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Role of Boundary Objects in Knowledge Co-Creation: A Case Study of a Service Co-Design Workshop

Master's Thesis

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Abstract

In the increasingly service based economy, the ability to design great services is crucial. When co-designing services, knowledge co-creation is in a central role. Based on theory, the use of boundary objects can help such knowledge co-creation.

Therefore, this study examines role of boundary objects in knowledge co-creation during a service co-design workshop. The study aims to increase understanding about how boundary objects influence knowledge co-creation in service co-design workshops. The research approach is qualitative – with abductive reasoning – and uses a single-case research method.

The literature review investigates relevant theory about knowledge co-creation, boundary objects, and boundary objects in service co-design. Also, some relevant theory about workshop facilitation is included.

The empirical case is one service co-design workshop. Two workshop teams are examined. The empirical data are discussion audios, videos, photos, and researcher's observations from the workshop. During the workshop, two types of boundary objects were used: 1) a service prototype that was created beforehand, and 2) posters – on which participants draw service related ideas – that were co-created during workshop.

The results of this study indicate that boundary objects do effectively support the co-creation of relevant knowledge in service co-design workshops. There are several mechanisms through which boundary objects achieve this. The type, usage, and purpose of a boundary object as well as the aim and characteristics of the service co-design workshop all partly determine how the boundary object influences knowledge co-creation. Also, factors such as time pressure, focus of participants and competent facilitation by workshop facilitators can be important for realizing the benefits of boundary objects.

Keywords: boundary object, knowledge creation, knowledge co-creation, co-design, service co-design

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Tiivistelmä

Entistä enemmän palveluista koostuvassa taloudessa kyky kehittää erinomaisia palveluita on keskeistä. Tiedon yhteisluominen on keskeisessä roolissa palveluiden yhteiskehittämisessä. Teorian perusteella rajaesineiden käyttö voi edistää tällaista tiedon yhteisluomista.

Siksi tämä tutkimus tarkastelee rajaesineiden roolia tiedon yhteisluomisessa palvelun yhteiskehittämistyöpajan aikana. Tutkimus pyrkii lisäämään ymmärrystä siitä, kuinka rajaesineiden käyttö vaikuttaa tiedon yhteisluomiseen palvelun yhteiskehittämistyöpajoissa. Tutkimusote on kvalitatiivinen – abduktiivisella päättelyllä – ja tutkimusmenetelmänä on yhteen caseen perustuva tapaustutkimus.

Kirjallisuuskatsaus käy läpi relevanttia teoriaa tiedon yhteisluomiseen, rajaesineisiin ja rajaesineisiin palvelun yhteiskehittämisessä liittyen. Lisäksi työhön on sisällytetty työpajojen fasilitoinnin teoriaa.

Tutkimuksen empiirinen osa perustuu yhteen palvelun yhteiskehittämistyöpajaan. Siinä tarkastellaan kahta työpajan tiimiä. Empiirinen data koostuu keskusteluaudioista, videoista, valokuvista sekä tutkijan havainnoista työpajasta. Työpajan aikana käytettiin kahdentyyppisiä rajaesineitä: 1) palveluprototyyppiä joka luotiin etukäteen ja 2) julisteita – joihin osallistujat piirsivät palveluun liittyviä ideoita – jotka yhteisluotiin työpajan aikana.

Tutkimuksen tulokset viittaavat siihen, että rajaesineiden avulla voidaan edistää relevantin tiedon yhteisluomista palvelun yhteiskehittämistyöpajoissa. Rajaesineet saavuttavat tämän useiden eri mekanismien seurauksena. Rajaesineen tyyppi, käyttötapa ja tarkoitus sekä palvelun yhteiskehittämistyöpajan tavoite ja erityispiirteet kaikki osittain määrittävät kuinka rajaesine vaikuttaa tiedon yhteisluomiseen. Lisäksi tekijät kuten aikapaine, osallistujien keskittyminen sekä ammattitaitoinen fasilitointi työpajan fasilitaattoreilta voivat olla tärkeitä rajaesineiden hyötyjen toteutumiseksi.

Avainsanat: rajaesine, tiedon luominen, tiedon yhteisluominen, yhteiskehittäminen, palvelun yhteiskehittäminen

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1 Introduction

1.1 Key Terms

This subchapter tells concisely how some key terms are defined in this study.

MORFEUS: A research project related to social care, healthcare, and wellbeing fields. It acted as context of this study.

Peili: A prototype of a service platform aimed at social care, healthcare and other wellbeing field professionals and their customers. Peili was used as a boundary object in this study.

Knowledge creation: The process of creating new knowledge.

Knowledge co-creation: Knowledge creation in social interaction (Smeds & Pöyry-Lassila, 2011). Also, boundary objects have a role in knowledge co-creation of this study.

Triological learning: A concept that sees knowledge creation as developing collaboratively shared objects. (Paavola & Hakkarainen, 2005). In this study, knowledge creation and knowledge co-creation are seen similarly.

Co-design: Essentially knowledge co-creation in innovative knowledge communities (Smeds & Pöyry-Lassila, 2011). More specifically, this knowledge co-creation aims to design something, for example a service.

Service co-design: Co-design activity focused on a service.

Boundary object: an object that is used as vehicle of knowledge and aggregator of knowledge co-creation in collaborative encounters (Pöyry-Lassila et al., 2013). Therefore, boundary objects support knowledge co-creation.

Innovative knowledge community: A group of people where knowledge is shared, and new knowledge is co-created through the process of triological learning. IKCs are intentionally formed to create and advance knowledge related to specific field. (Paavola et al., 2004; Smeds & Pöyry-Lassila, 2011)

1.2 Background and Motivation

In many developed countries, the share of services of nominal GDP is 70-80%, and for example in the United States over 80% (CIA, 2018). In the increasingly service based economy, the ability to design great services is crucial. When co-designing services, knowledge co-creation is in central role: service co-design is essentially knowledge co-creation (Smeds & Pöyry-Lassila, 2011). Consequently, if boundary objects can help such knowledge co-creation, the competent usage of boundary objects may lead to better services.

This study investigates the role of boundary objects in knowledge co-creation and uses a case study of a service co-design workshop as empirical data. The study provides more understanding about the role of boundary objects in knowledge co-creation, and how to utilize them effectively in service co-design workshops. The study was done as a part of MORFEUS-research project, and as a master's thesis for Aalto University. More information about MORFEUS and context of this study is found in Chapter 3.1.1.

1.3 Research Questions and Goal

The main research question is:

How do boundary objects influence on the knowledge co-creation when co-designing services during a workshop?

The main research question has general nature, so this study does not aim to answer it comprehensively, but rather to provide some insights related to it based on a case study.

Also, two more specific research questions were formed to support answering the main research question:

- 1. How did Peili as boundary object influence the knowledge co-creation when co-designing services during the workshop?***
- 2. How did posters as boundary objects influence the knowledge co-creation when co-designing services during the workshop?***

This study's goal was to increase understanding about how boundary objects influence knowledge co-creation in service co-design workshops.

1.4 Research Approach and Scope

The research approach of this study is qualitative. Qualitative research is an effective approach to research phenomena related to humans and groups of humans and their interaction. Also, qualitative approach is suitable for interpreting context and meanings related to such phenomena. Qualitative approach is also good at studying in depth unique and complex human activities. All these characteristics are important for this study. Therefore, qualitative approach is the most suitable research approach for this study. (Kohlbacher, 2006; Creswell, 2009)

The research method of this study is a single-case study. This study examines the nature of phenomena related to boundary objects, knowledge co-creation and service co-design by answering to ‘how’ research questions based on empirical data gathered during one real-life workshop. For this kind of study, qualitative single-case research method is suitable. (Yin, 2009; Creswell, 2009) The case is described in Chapter 3.1: *Case Description*.

This study utilizes abductive reasoning (Dubois & Gadde, 2002). Abductive reasoning is an effective approach for case studies, since it helps to create a deep understanding about a unique case and its relation to theory (Eisenhardt, 1989). With such logic, this study uses incomplete observations of a single qualitative case study to make the best possible conclusions about the theoretical explanations of the phenomena. As is characteristic for abductive reasoning, theoretical understanding is iteratively combined and compared with results of this empirical study (Dubois & Gadde, 2002). Therefore, the initial literature review of relevant theory was written already before empirical data analysis. Then, the literature review was continued and completed during and after creating Empirical Findings, Results, and Conclusions chapters of this study.

The empirical part analyzes the knowledge co-creation through the analysis of the formation process of ideas during the service co-design workshop. The empirical data is from a single-case study, gathered during a single workshop. Information about the research process as well as data gathering and data analysis of this study can be found in Chapter 3.

1.5 Structure of the Study

This thesis consists of six chapters. They are presented in chronological order in *Figure 1*. The first chapter defines some key terms concisely, gives background and motivation to this study, defines research questions and goals, and describes the research approach.



Figure 1: Structure of this Study

The second chapter is literature review about knowledge co-creation, boundary objects and the role of boundary objects in service co-design.

The third chapter describes the empirical case and research process of this study. Case Description subchapter describes the context of this study: MORFEUS-project, the prototype used as boundary object: Peili, data gathering and data analysis of this study. Research Process subchapter shows all research phases in chronological order and then explains in more detail some important phases: the seminar, and the workshop where the data was gathered.

The fourth chapter describes and analyzes the empirical findings gathered during the workshop. The most important co-created knowledge – ideas drawn on posters by the workshop teams – are described and analyzed. Also, empirical observations about Peili's influence on knowledge co-creation are described. Finally, the chapter summarizes empirical findings and compares the two workshop teams with each other.

The fifth chapter analyzes empirical findings by utilizing theoretical perspective. It combines theory and empirical findings and forms a synthesis. The role of boundary objects (PEILI and posters) in the knowledge co-creation is analyzed and compared to relevant theory.

The sixth and final chapter answers to the research questions, suggests practical and theoretical implications as well as potential future research areas, and finally evaluates the study.

2 Literature Review

2.1 Knowledge Co-creation

2.1.1 Importance of Knowledge Co-creation

Knowledge and knowledge creation is often seen as an important source of competitive advantage (e.g. Argote & Ingram, 2000; Winter, 1987). Knowledge and knowledge creation ability is important for example for technical, product and organizational innovations (Nonaka, 1994).

Yet, less attention seems to be paid to how organizations can create knowledge (Nonaka et al., 2000). Blackler (1995) suggests that instead of focusing on just knowledge itself, more attention should be put on systems through which people achieve their knowing and on the processes through which new knowledge may be generated. This study addresses these issues by studying how boundary objects can be used for knowledge co-creation.

2.1.2 Knowledge Co-Creation definitions

To define *knowledge co-creation*, *knowledge creation* needs to be defined first. Knowledge creation is close to concepts such as *knowledge acquisition*, *knowledge building* (Bereiter, 2002), *organizational knowledge-creation*, and *expansive learning*. All these concepts can be seen as different approaches to knowledge creation. (Paavola & Hakkarainen, 2005)

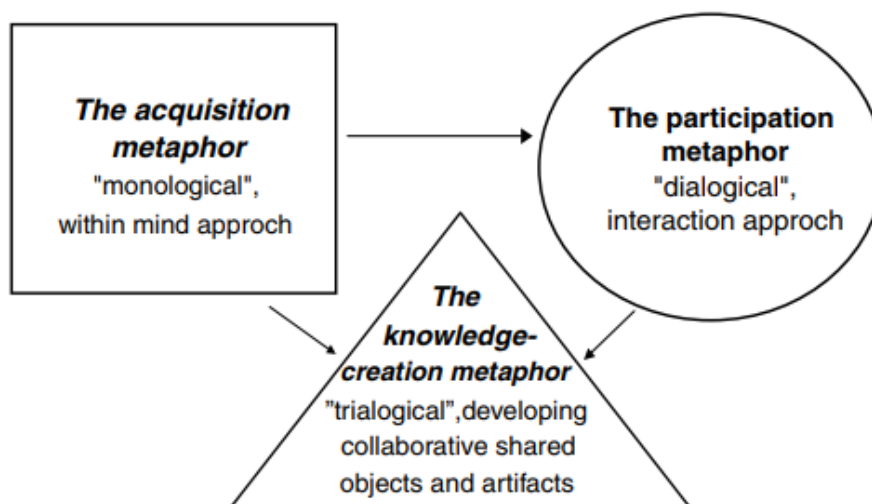


Figure 2: Three metaphors of learning (Paavola & Hakkarainen, 2005)

Paavola and Hakkarainen (2005) define knowledge creation through their *trialogical learning*: knowledge creation is seen as ‘developing collaborative shared objects and artefacts’. In trialogical learning approach, knowledge creation requires at least two people that have at least one shared object or artefact involved in their interaction. Three metaphors of learning are presented in *Figure 2*. This figure shows how trialogical learning approach to learning considers learning as knowledge creation, compared to dialogical approach that lacks the element of (boundary) object but requires at least two people participating and monological, knowledge acquisition approach that requires only one person. Of these three metaphors of learning, only the ‘trialogical’ knowledge creation metaphor is relevant for knowledge co-creation that involves boundary objects. (Paavola & Hakkarainen, 2005)

On the other hand, Nonaka & Takeuchi (1995) define knowledge creation using concepts of tacit and explicit knowledge as well as knowledge spreading on four different levels: individual, group, organizational and inter-organizational. *Figure 3* presents the SECI-process by Nonaka et al. (2000). Perhaps the most relevant parts of this process for knowledge co-creation in our study are the upper right quadrant and the lower right quadrant: tacit to explicit and explicit to explicit. Nonaka calls tacit to explicit knowledge creation externalisation and articulating. For example, when workshop participants draw their ideas on posters, their knowledge is externalized. Also, if a participant merely mentions an idea in discussion, then ‘articulating’ describes it well. When these ideas are discussed and drawn on posters collaboratively by many participants, then the explicit to explicit connecting and combination processes lead to knowledge co-creation. (Nonaka et al., 2000)

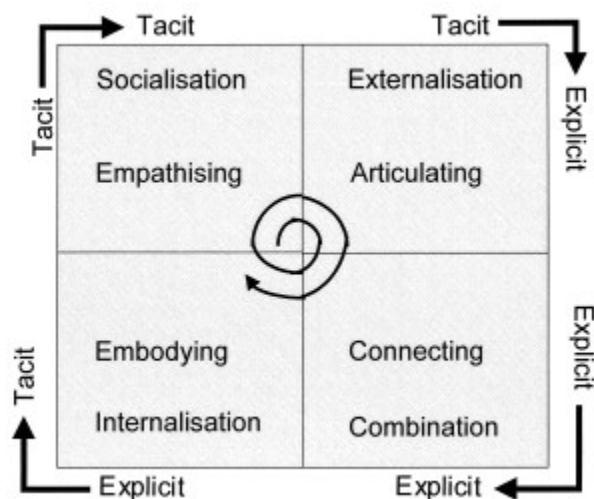


Figure 3: The SECI process (Nonaka et al., 2000)

Another concept relevant for knowledge co-creation in this study is ‘knowledge building’ by Bereiter (2002). Knowledge building highlights the role of ideas – conceptual artefacts – that act as outcomes of knowledge co-creation, but also as the main tools for reaching the outcomes. Knowledge building is a process where a community creates conceptual artefacts and uses them as tools to co-create new knowledge. (Bereiter, 2002)

2.1.3 Knowledge Co-creation in Service Co-design

Albinsson et al. (2007) present a co-design approach suitable for service development. They argue that when trying to innovate in networks (as opposed to within just one company), it is crucial to cross the borders between differing people and perspectives while keeping the end customer on focus. According to them, a co-design scenario, which is a first-person story about an end customer, can be an effective approach for achieving this.

Co-design can be understood as a form of knowledge co-creation. For example, Smeds and Pöyry-Lassila (2011) define co-design as knowledge co-creation in innovative knowledge communities. In this paper co-design is defined the same way. Consequently, theory of knowledge (co-)creation can be directly utilized when discussing co-design of services.

The paper by Pöyry-Lassila et al. (2013) connects the theory of knowledge creation to design research. They state that theory that is relevant to both knowledge co-creation and co-design is the view that new knowledge is created through practical engagement with objects. Therefore, it is justified that our study examines the combination of knowledge co-creation, service co-design and boundary objects.

Based on the theory above, service co-design seems a natural and important application area for the theory of knowledge (co-)creation, where this kind of research may create significant value for organizations and organizational networks. Also, boundary objects are closely related to knowledge co-creation. Therefore, the next subchapter discusses theory about boundary objects.

2.2 Boundary Objects

In the previous chapter, the overlapping concepts of knowledge co-creation and service co-design were discussed. However, in this study, it is important to understand how both activities can be performed effectively. Based on theory, a potentially effective approach is to use boundary objects. This subchapter presents some of that theory.

2.2.1 Boundary Object Definition

In 1989 Star and Griesemer wrote a widely used article about boundary objects. They list two activities that are crucial for translating between viewpoints (this means creating understanding between people with different perspectives): 1) standardization of methods and 2) the development of boundary objects.

They describe boundary objects to be flexible enough to adapt to local needs but also ‘robust enough to maintain a common identity across sites’. In other words, even the same boundary objects have different meanings in different communities, but their structure is recognizable and understandable across different contexts. Therefore, boundary objects are in key role when developing common understanding across different social worlds. (Star & Griesemer, 1989)

In her 2010 article Star summarizes three key components of boundary objects:

- 1) ‘Interpretive flexibility’,
- 2) ‘the structure of informatic and work process needs’ and
- 3) ‘the dynamic between ill-structured and more tailored uses of the objects’.

However, she continues that interpretive flexibility is easily the most cited and used (in theory) of these three aspects. Interpretive flexibility means that different people, different communities – or in different contexts – interpret boundary objects different ways in create different meanings and knowledge related to them. The structure of informatic and work process needs refers to the adaptation of boundary objects based on specific needs of the users. For example, in Star’s (2010) own study, an electronic data sharing system satisfied the work needs of biologists. The component 3) means that boundary objects can be vague and abstract (ill-structured) or they can be made more specific, more tailored for a specific local context. The more tailored they are, the more useful they may be within a local use by users having similar perspective with each other. On the other hand, the more tailored for one perspective a boundary object is, the less effective it may be as a boundary object between different communities of practice. (Star, 2010)

Paavola and Hakkarainen (2005) describe two essential roles for boundary objects: 1) they can be objects that are co-created but also 2) serve as catalysts for the co-creation process. As later shown in this paper, these two roles for boundary objects are central in our study too. Furthermore, in their article about service co-development and co-design, titled 'The roles of objects in collaborative workshops', Pöyry-Lassila et al. (2013) defined boundary object as 'an object that is used as vehicle of knowledge and aggregator of knowledge co-creation in collaborative encounters'. The field and context of their study is similar as this one, so therefore their definition is very relevant in this study too.

2.2.2 Importance of Boundary Objects

As mentioned in the previous subchapter, boundary objects are important when translating between different viewpoints (Star & Griesemer, 1989). This way boundary objects can help people with different backgrounds, fields, expertise, culture, or perspective better understand each other, communicate, and collaborate.

Carlile, Nicolini, Langley & Tsoukas (2013) sharply criticize the lack of attention to objects in social research. According to them, towards the end of twentieth century social science focused more on language and marginalized objects during the time when objects, artefacts and technical systems became increasingly important in human lives. They argue that objects and artefacts matter in organizational activity, and therefore deserve more attention in research. They continue that organizational sense-making, cognition, knowledge, learning and perceiving are enacted through 'sociomaterial practices', which means that organizational members learn to do certain things through the use of objects. Thus, objects are important for organizational success. These claims seem also relevant in the context of our study – using boundary objects for knowledge co-creation in service co-design. (Carlile et al., 2013)

Nicolini, Mengis and Swan (2012) highlight the role of objects in cross-disciplinary collaboration. They argue that objects 1) motivate collaboration, 2) allow participants to work across different types of boundaries and 3) constitute the fundamental infrastructure of cross-disciplinary collaboration activity. All these benefits are important for knowledge co-creation in service co-design context too. Moreover, Carlile (2004) highlights the effectiveness of boundary objects in new product development. New product development is similar application area to co-designing new services, which make Carlile's finding interesting for this study too. (Nicolini, Mengis & Swan, 2012)

Furthermore, Kirsh (2010) discusses how external representations, which may be considered boundary objects, enhance cognitive power. He lists seven ways external representations accomplish this. External representations: 1) reduce cognitive cost of sense making, 2) provide a structure that can be used as shareable object of thought, 3) create persistent referents, 4) facilitate re-representation, 5) may be more natural representation of structure than mental representations, 6) facilitate computing more explicit encoding of information and 7) enable constructing more complex structures. As the consequence of these benefits, they help coordinate thought. These benefits of external representations can be understood as potential benefits of boundary objects that would be helpful for co-creating knowledge when co-designing services. (Kirsch, 2010)

2.2.3 Types of Boundary Objects

According to Star and Griesemer (1989), there are four types of boundary objects: *repositories*, *ideal types*, *coincident boundaries* and *standardized forms*. *Repositories* are ordered piles of objects which are indexed in a standardized fashion. *Ideal types* are abstract and fairly vague descriptions such as diagrams or collection of maps. Thanks to their vagueness, ideal types adapt to different situations and are suitable for communication and cooperating symbolically. *Coincident boundaries* are objects that have same boundaries but different contents with each other. An example would be two maps of the same area so that each map highlights different things: For instance, two maps of Africa: one that shows ecological zones, and one that shows population density. Finally, *standardized forms* help communication across dispersed work groups by gathering information in standardized fashion. Therefore, they result in standardized indexes that are understood the same way in different locations and by different types of people. From these types, *ideal types* may be the most relevant for our study, because boundary objects of this study resemble most that type. (Star & Griesemer, 1989)

Carlile (2002) categorizes knowledge boundaries in product development into three types of boundaries: syntactic, semantic, and pragmatic. Syntactic approach to boundaries highlights the importance of mutual syntax or language with which to communicate. Without the same syntax or language understanding each other is difficult. Semantic approach to boundaries is more complex: even with mutual language or syntax, people may make different interpretations which make communication and collaboration difficult. The pragmatic approach sees knowledge, and thus boundaries, as localized and embedded in practice or a function. Because of pragmatic boundaries, people do not have mutual understanding about what exactly to do or aim at (Carlile, 2004). Therefore, pragmatic knowledge boundaries often arise when working

across functions. Obviously, common understanding about tasks and goals (pragmatic boundaries) of service co-design workshop, as well as ability to communicate with other participants (syntactic and semantic boundaries) are important, which makes this theory useful for our study. (Carlile, 2002)

Carlile (2002) also divides boundary objects into different types based on with which type of boundaries they work with. A suitable boundary object for crossing syntactic boundaries is one that ‘establishes a shared syntax or language for individuals to represent their knowledge’. For example, if both engineers and assemblers are familiar with a specific type of assembly drawings, such drawing may then provide them a common syntax and thus act as effective boundary object. (Carlile, 2002)

For crossing semantic boundaries – according to Carlile – an effective boundary object provides means for individuals to understand their differences and dependencies across a given boundary. Such boundary object allows individuals to specify what they know or worry about as concretely as possible about the problem. (Carlile, 2002)

Finally, an effective boundary object for crossing pragmatic boundaries facilitates a process where individuals can jointly transform their knowledge into common understanding. A good example about Carlile’s (2002) pragmatic boundaries and developing pragmatic boundary objects to cross them, is Bechky’s (2003) study. In that study engineers, assemblers and technicians had difficulties understanding each other. They managed to create shared understanding, and solve the problem, by using ‘tangible definitions’ that were examples that physically exhibited the problem in a clear way. As Bechky (2003) herself interprets it, the tangible definitions served as boundary objects that created common ground between different knowledge communities. Therefore, tangible definitions (physically pointing out a problem/situation), can be seen as a pragmatic boundary object. (Bechky, 2003)

Although boundary objects and their benefits described in this subchapter are relevant in service co-design too, the next subchapter examines even more directly relevant theory for role of boundary objects in service co-design.

2.3 Boundary Objects in Service Co-Design

2.3.1 Boundary Objects in Knowledge Co-Creation

Regarding to the relationship between boundary objects and knowledge co-creation, trialogical learning by Paavola and Hakkarainen (2005) is very relevant, because the concept has (boundary) objects in central role in knowledge creation. The concept also requires that there are at least two people for knowledge creation to happen. Therefore, the knowledge creation according to concept of trialogical learning is by definition knowledge co-creation.

Moreover, Hakkarainen and Paavola (2009) list six characteristics of trialogical learning:

1. Focus on *shared objects of activity* which are developed collaboratively. These objects may be e.g. designs, or prototypes.
2. *Sustained and longstanding pursuit of knowledge advancement*. This knowledge advancement may be e.g. new ideas and innovations.
3. Knowledge-creation processes taking place in *mediated interaction between individual and collective activities*.
4. *Cross-fertilization of knowledge practices between different knowledge communities*, such as educational, professional and research communities.
5. *Technology mediation*. Appropriate technology is necessary for participants to effectively interact with knowledge artefacts.
6. *Development through transformation and reflection*, where novel ideas form through interaction between individuals and objects. (Hakkarainen & Paavola, 2009)

These six characteristics (Hakkarainen & Paavola, 2009) are relevant and suitable for our study and for knowledge co-creation in situations such as service co-design workshops, because in such situations too:

1. (boundary) objects are used and may be developed collaboratively,
2. the workshop goals tend to be related to knowledge advancement (e.g. creating new knowledge and understanding about a service)
3. individuals participate in collective activities where knowledge is co-created
4. the knowledge across participants is often diverse (e.g. innovative knowledge communities (Paavola et al., 2004; Smeds & Pöyry-Lassila, 2011))
5. technology and tools are commonly used (e.g. projectors, digital prototype in the empirical part of our study)

6. knowledge tends to form through interaction, reflection and usage of objects.

Consequently, knowledge creation according to the concept of trialogical learning is a suitable and appropriate theory to be utilized when studying role of boundary objects in knowledge co-creation and during service co-design workshops, like in our study.

Eppler and Burkhard's (2007) findings indicate that visual representations can be beneficial in knowledge management. Consequently, they encourage researchers to actively experiment with new forms of visual knowledge representations and to evaluate their benefits and potential drawbacks. They also suggest exploring visual representations in practical organizational situations. (Eppler & Burkhard, 2007)

Boundary objects are often visual representations. Also, service co-design workshops are practical organizational situations. Therefore, the theory by Eppler and Burkhard (2007) can be interpreted to encourage both researchers and practitioners to use and experiment with (visual) boundary objects in service co-design situations such as workshops.

Eppler and Burkhard's study (2007) focuses more on visualizing knowledge than creating actual boundary objects. Yet, some of the objects in their knowledge visualization examples have clear characteristics of effective boundary objects. For example, they introduce 'heuristic sketches' that are 'drawings used to assist the personal or group reflection and communication process by making knowledge-in-progress explicit and debatable'. Heuristic sketches seem to be a method for knowledge creation by making tacit knowledge explicit (externalization) like how Nonaka and Takeuchi (1995) described how knowledge is created. (Eppler & Burkhard, 2007)

Moreover, Eppler and Burkhard define a sketch as: 'a rough drawing or painting in which an artist notes down his preliminary ideas for a work that will eventually be realized with greater precision and detail'. According to the article, heuristic sketches allow various interpretations and foster the creativity in groups. They also help to capture insights of individuals on how people perceive reality and think about a concept. (Eppler & Burkhard, 2007)

Theory presented in this subchapter indicates that boundary objects – whether they are called 'visual representations' such as 'heuristic sketches' (Eppler & Burkhard, 2007) or objects that are part of knowledge creation process like in trialogical learning (Hakkarainen & Paavola, 2009) – are often beneficial in knowledge co-creation, even likely in situations such as service co-design workshops. However, the next

subchapter examines more directly the role of boundary objects specifically in the context of co-designing services.

2.3.2 Boundary Objects in Co-Designing Services

Hakkarainen and Paavola (2009) discuss how collaborative designing is a trialogical experience. That directly – even more directly than their theory presented in previous subchapter – indicates that trialogical learning is applicable specifically in the context of co-designing services.

Similarly to Kirsh (2010), Blomkvist and Segelström (2014) use the term ‘external representation’ (instead of term boundary object). However, their external representations seem to fulfill the definition of boundary objects too, especially when external representation is used in specific context such as co-designing services. Therefore, these articles are relevant for topic of our study and this subchapter. (Blomkvist & Segelström, 2014)

Moreover, Blomkvist and Segelström discuss external representations and their benefits specifically in the context of service design. According to them, there are two main types of external representations in service design: visualizations and prototypes. Based on this, visualizations and prototypes are effective boundary objects when co-designing services. (Blomkvist & Segelström, 2014)

Pöyry-Lassila et al. (2013) analyze the roles of objects in collaboration. More specifically, they focus on roles of objects in service co-development workshops, which is very relevant for this study. Their findings indicate that contextual factors affect the way objects are used in co-development. They identified four such factors:

1. the aim of co-development (e.g. to create new ideas or to develop something that exists)
2. the aim of the workshop (e.g. to elicit participants’ views through objects made by them or to use objects predesigned by facilitators)
3. the phase in the service development
4. the approach (e.g. emphasis on the rational or the emotional). (Pöyry-Lassila et al., 2013)

Smeds and Pöyry-Lassila (2011) studied the topic of ‘Co-designing value networks in process simulations’. They defined co-design as knowledge co-creation in innovative knowledge communities. Their definition

is relevant in this study too. They used three types of boundary objects: process models, scenarios and visualized speech citations. These boundary objects worked ‘both as important catalysts and objects of co-design’ – similarly to how Paavola and Hakkarainen (2005) describe main roles of boundary objects – and therefore were important for the success and results of the co-design process. (Smeds & Pöyry-Lassila, 2011)

Earlier, Paavola et al. (2004) analyzed ‘innovative knowledge communities’ in more detail. They examined what innovative knowledge communities are, and what kind of communities tend to create innovative knowledge. They presented three models of such communities, largely based on the same theory and same mechanisms already presented in this literature review: e.g. concepts of knowledge building (Bereiter, 2002) and externalization of tacit knowledge (Nonaka & Takeuchi, 1995). This also indicates that such theory is relevant for service co-design. (Paavola et al., 2004)

Pirinen (2016) has identified barriers and enablers of co-design of services. These barriers and enablers are divided into five separate categories and each barrier and enabler is related to one category. The categories are: Collaboration (finding a common ground), Organisation (creating commitment), Processes (being integrated), Implementation (making an impact) and Methods (becoming a practice). (Pirinen, 2016)

Some of these barriers may be turned into enablers by effective use of boundary objects. Especially the barriers of the Collaboration category presented by Pirinen might be turned into enablers by using boundary objects. For instance, Pirinen lists ‘Differences in language and culture’ as one barrier and ‘Credible, responsive communication’ as corresponding enabler of co-design for services. For example, syntactic and semantic types of boundary objects (Carlile, 2002) seem effective for turning this barrier into enabler. Also otherwise, boundary objects can improve communication and understanding between different kinds of people. (Pirinen, 2016)

Co-design of services is by nature a collaborative innovation activity. Smeds et al. (2014) characterize collaborative innovation as ‘a process of knowledge co-creation over boundaries’. In their study, visual boundary objects were used to co-develop educational processes in three discussion-based workshops. These workshops successfully supported co-creation of novel ideas for educational innovations. The

boundary objects had a major role in achieving the co-development results. This indicates that boundary objects often are – or should be – in a major role when co-designing services. (Smeds et al., 2014)

Levina (2005) proposes that in multi-party collaborative practice, an information system design ‘emerges because of agents producing, sharing, and reflecting upon material objects’. She points out that an object may be perfectly suitable to serve as an effective boundary object in such situation, but still the agents do not actively use it. Obviously, when boundary objects are not utilized they do not create any benefit. Therefore, to realize benefits from boundary objects when co-designing services, it is important that 1) they are actively used and 2) how they are used. (Levina, 2005)

In their 2005 article, Levina and Vaast discuss boundary spanning and boundary spanners. By ‘boundary spanners’ they refer to agents who produce and use objects that become boundary objects-in-use. Especially, when boundaries are high, such as in information system development projects, especially in offshored ones, boundary spanners are important for the success of the project (Levina & Vaast, 2008). These concepts are relevant for effective usage of boundary objects in service co-design.

Furthermore, Levina continues, if a design prototype that is used as a boundary object is left unchallenged, it may inhibit collaboration. Therefore, it may be beneficial to encourage participants to challenge the current prototype and creatively consider different types of designs too when using a prototype as a boundary object. This is very relevant in this study because the boundary object used (Peili) is an information system prototype, similarly to the boundary object in Levina’s study. (Levina, 2005)

Levina also talks about participants ignoring boundary objects in collaborative activities. She lists several common reasons for this: sometimes the ignoring is caused by being unaware of the object, being unable to access it or lacking competence necessary for interpreting it. Yet, even when these causes were not true, participants often ignored objects produced by others to ‘reaffirm their professional, organizational, or project involvement-based identities’. (Levina, 2005)

As a conclusion, Levina (2005) recommends researching practices surrounding the use of a boundary object instead of just focusing on the boundary object itself. Following her advice, our study focuses on how boundary objects are used in service co-design workshops.

2.3.3 Facilitating Service Co-Design Workshops

To effectively use boundary objects for knowledge co-creation in service co-design workshops, competent facilitation is in important role. Like in our empirical study, often such workshops have selected facilitators, who are responsible for the facilitation.

There are many responsibilities for facilitators: they may give participants turns to speak, give instructions for workshop tasks and monitor participants' progress on these assignments. Also, facilitators steer participants towards active participation in discussions and workshop tasks. When a workshop discussion has a goal – as the discussions in this study – the facilitator may try to direct the discussion to be more productive towards accomplishing the goal – such as forming ideas related to a service. Consequently, facilitators may direct the interaction intentionally, and thus have a major influence on what knowledge is co-created during a workshop. (Hirvensalo, 2015; Nielsen, 2012, pp. 106).

Depending on situation and person, a facilitator may have many different roles. For example, the same person may be both researcher and facilitator. Especially then, but also otherwise, facilitators often must take other roles too – such as ones listed by Herbert (2010):

'politician': there are many stakeholders involved in workshops each of which has own interests and power with which facilitators must deal

'magician': the facilitator must take care of many practical things to ensure the co-creation during a workshop goes smoothly

'trader/traitor': facilitators must deal with issues of trust and trade-offs between their own interests and needs and expectations of workshop participants – especially if the facilitator is also a researcher or otherwise has interests other than the facilitation itself

'ventriloquist': on one hand, the facilitator must make room for many people to speak, but on the other hand the facilitator will represent some voices more than the others. (Herbert, 2010)

Consequently, facilitating a workshop is a complicated and demanding task that requires many choices and actions from the facilitator.

Kaner (2014, pp. 149-153) lists many classic challenges for facilitators. Some of them – the most relevant ones for this study – and effective responses by the facilitators are listed here:

- Challenge: Domination by a highly verbal member

- **Effective response:** Encourage other members to participate more
- Challenge: Several different topics being discussed at the same time
 - **Effective response:** Summarize the key themes being discussed. Encourage participants to link their ideas to the central tasks or goals of the workshop. Create a 'parking lot' where ideas are saved to be accessible later.
- Challenge: poor follow-through on assignments
 - **Effective response:** Assign the work to teams. Make teams report back the progress of their assignment already at the midpoint of time allocated to the task.
- Challenge: Quibbling about trivial procedures
 - **Effective response:** Make the team step back from the details of the issue. Ask "What is really going on here?" (Kaner, (2014))

In conclusion, facilitators and their actions are one factor that can have a significant effect on service co-design workshops and the role of boundary objects in knowledge co-creation there.

3 Case Description and Research Process

3.1 Case Description

3.1.1 MORFEUS Project – Context and Starting Point of the Study

This study was done as a part of MORFEUS research project, which focused on the well-being and healthcare service ecosystem in Finland. The aim of MORFEUS was to find ways to make healthcare and well-being service ecosystem more customer-centered and effective.

During the earlier phases of MORFEUS-project, various empirical data was already gathered. It was gathered through interviews, workshops and other methods. Based on these earlier phases of MORFEUS, some problems and unfulfilled needs in the Finnish well-being ecosystem were discovered.

Based on those needs, discovered earlier in the MORFEUS project, MORFEUS researchers realized that there is a need for a specific kind of digital well-being platform. Such a platform would facilitate collaboration and knowledge sharing between different kinds of well-being professionals as well as between those professionals and their customers. To gain better understanding of what kind of digital platform could potentially be useful, the development of Peili (in English: “Mirror”) – a digital wellbeing service prototype – was started. The first version of prototype was developed in March 2016 and the fourth version in early June 2016. This fourth prototype version was introduced to participants and used as a boundary object in the seminar held from June 15th to 16th, 2016.

3.1.2 Peili – Digital Wellbeing Service Prototype

The digital wellbeing service Peili aims at improving collaboration and knowledge sharing between different well-being professionals related to their mutual clients. Secondly, it aims at improving collaboration between clients and professionals as well as professionals’ access to all their clients’ well-being information. Thirdly, an important goal of Peili is to empower the customer by giving access to all personal well-being information as well as by offering relevant digital tools and resources.

In this study, the word ‘Peili’ is used to refer to the user interface views of the service prototype. Peili has dashboard views for customer interface and case manager/professional interface. A picture of Peili’s customer interface’s ‘My Data’ view is in *Appendix 1* at the end of this paper. A picture of Peili’s Case manager/Professional Planning tool view is also in *Appendix 1*.

PEILI

My Health

Support Network

Messages

Objectives

Services


My Data

Log out

Pillars of my well-being

Tasks completed

Tasks in progress



Hi Sam Citizen!

Notifications





Type	Subject	Status	
My Health	Last 2 weeks	2 new comment(s)	OPEN
Application	Housing support	1 new comment(s) updated	Requires information OPEN
Application	Unemployment support	updated	Approved OPEN

My Health

Sender	Type	Topic	
Sam Citizen	My Health	Last 2 weeks	2 new comment(s) Open
Sam Citizen	My Health	Viimeiset 2 viikkoa	Open

+ Add new My Health-post

My Support Network

Name	Latest social update
 <div>Lauri Majuri</div>	 <div>Enjoying the summer! (From Facebook 1 week 5 days ago)</div>
 <div>Charles Bell</div>	 <div>Did some cycling today. Beautiful weather!! :) (From Facebook 1 week 5 days ago)</div>



My Messages

Messages

New Message

<input type="checkbox"/>	Subject	Participants	Last Updated
<input type="checkbox"/>	Jewellery Making	Kim Casemanager	Jun 9

My Helpers

Name	E-mail	Phone	
 <div>Danny Doctor</div>	danny.doctor@doctor.com	045-12345657	Send message
 <div>Kim Casemanager</div>	kim.casemanager@case.com	045-14257102	Send message

My Applications

Subject	Provider	Status	Amount	
Housing support	Kela	Requires information	500	Open
Unemployment support	Kela	Approved	400	Open

Picture 1: Customer's Dashboard view

PEILI

Notifications


To-Do

Customers

Messages

Planning tool

Log out



Hi Kim Casemanager!

Notifications

Customer	Type	Topic	Status
Sam Citizen	My Health	Last 2 weeks	1 new comment(s) OPEN
Sam Citizen	Application	Housing support	updated Requires information OPEN

Discuss

Messages

New Message

Subject	Participants	Last Updated
Jewellery Making	Sam Citizen	Jun 9

Notifications






Customer	Type	Topic	Status
Sam Citizen	My Health	Last 2 weeks	1 new comment(s) OPEN
Sam Citizen	My Health	Viimeiset 2 viikkoa	OPEN
Sam Citizen	Application	Housing support	updated Requires information OPEN
Sam Citizen	Application	Unemployment support	Approved OPEN

To-Do

Lähetäjä	Flagged time
Unemployment support Sam Citizen	10:30 am

Remove from To-Do list

Customers

E-mail	Phone
 <div>cherly.green@gmail.com (585)-380-4826 Send message</div> <div>Cherly Green</div>	
 <div>j.west@gmail.com (230)-699-1031 Send message</div> <div>Jeremy West</div>	
 <div>randy.harris@gmail.com (245)-773-5353 Send message</div> <div>Randy Harris</div>	
 <div>sam.citizen@gmail.com 041-465873172 Send message</div> <div>Sam Citizen</div>	
 <div>sonia.duncan@mail.com (652)-195-9411 Send message</div> <div>Sonia Duncan</div>	

Picture 2: Peili: Case manager/Professional Dashboard view

3.1.3 Data Gathering

The empirical data was gathered from the workshop that was part of the seminar held from June 15th to June 16th in 2016. In the workshop, Peili and posters were used as boundary objects for service co-design.

The dashboard views of Peili (Picture 1 and Picture 2) were projected onto the wall during the workshop. The posters were initially just empty sheets of paper. The workshop participants co-created ideas and drawings related to the service into the posters during the workshop.

The data consists of the material produced by two teams, since the audio recording of the third team failed. The posters and photos of them were used as data. The team discussions during the workshop were recorded with audio recorders and video cameras. Also, some photos were taken. The researcher was also a workshop participant, so he observed the workshop activities also firsthand.

3.1.4 Data Analysis

The data analysis method of this study was qualitative content analysis. Kohlbacher (2006) points out critiques about superficiality of quantitative content analysis, which tends not to consider the context of text components, latent structures of sense, distinctive individual cases and things that do not appear in the text. Qualitative content analysis better overcomes these issues and is therefore more suitable for data analysis in this study. Moreover, in qualitative content analysis the researcher makes subjective interpretations of data. Qualitative content analysis is often used in qualitative case research. It is suitable for discussion data, but also for analysis of other content formats such as photos. Since this study is a qualitative case study, and the phenomena and data in this study are closely related to human and social behavior, such qualitative approach to both data analysis and otherwise is the most natural and effective choice. (Kohlbacher, 2006).

Discussions of the workshop teams in audio recordings were afterwards transcribed into text to make the data analysis more effective. The researcher transcribed the first eight pages of text himself, and then hired a transcription firm to transcribe the rest (44 pages). The verbal discussion data and posters were then analyzed using qualitative content analysis methods.

This analysis focused on how knowledge was co-created – especially how service-related ideas were formed – during the workshop. Itemized lists were created from the ideas in the posters created by workshop teams. These lists are in *Appendix 3*. Then, the number and structure of ideas were analyzed. Finally, the transcribed discussion data was analyzed.

3.2 Research Process

The phases of research process are presented in *Figure 1*. The phases are in chronological order. The research process started with the researcher being involved in MORFEUS project and learning about it and some relevant topics, such as current issues and needs related to Finnish healthcare and social care ecosystem. Next, the iterative development process of Peili (see chapter 3.1.2) started. Then initial reading about some relevant theory was done. After this, the workshop and data gathering in it was planned and executed. Later, literature research and writing *Literature Review* chapter was started. As is typical for abductive reasoning, literature research phase then continued simultaneously with the data analysis phase, and while writing the results and conclusions of the study. Finally, this master's thesis was finished by completing the remaining parts, and improving the existing ones of this paper.

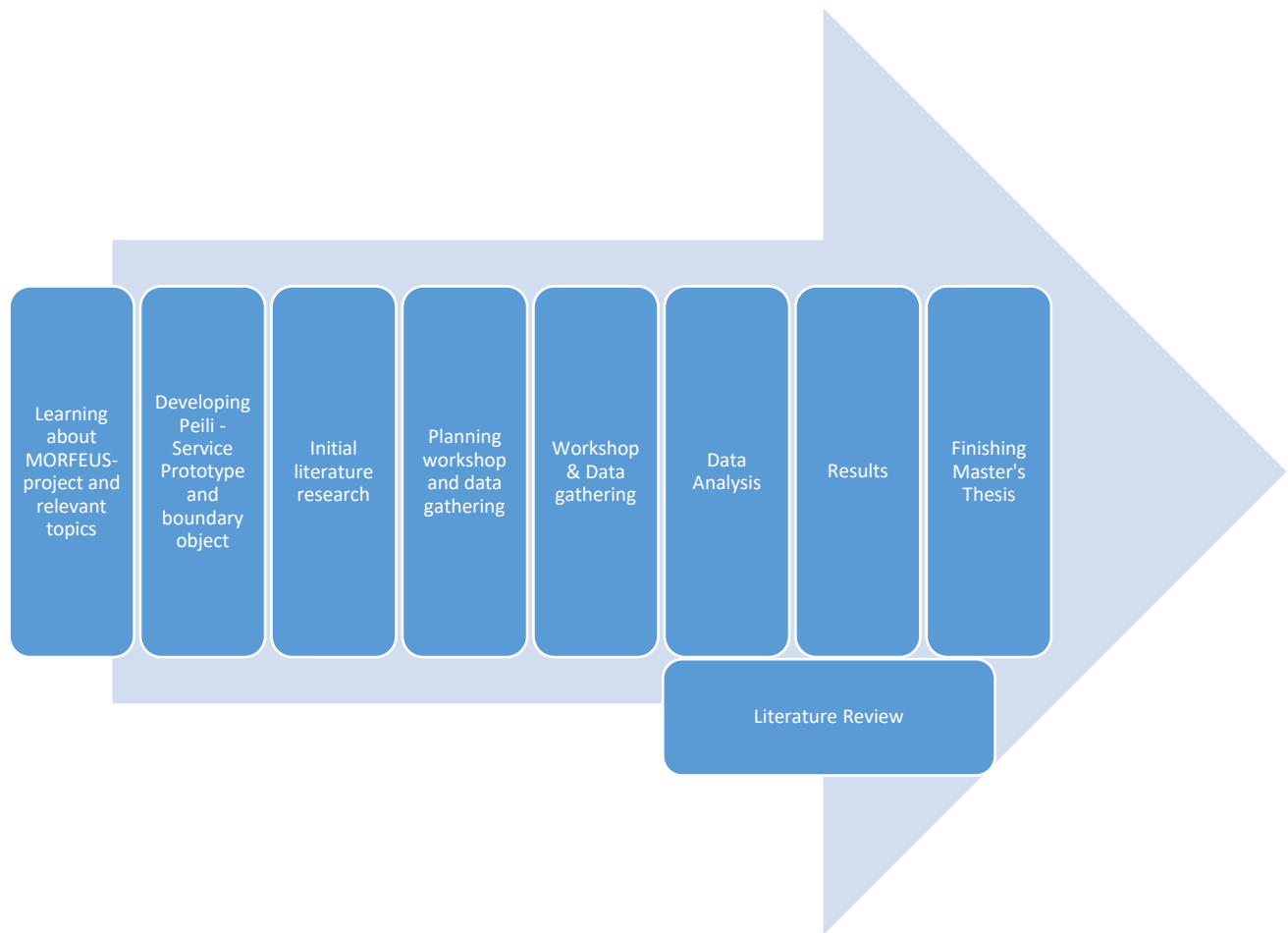


Figure 4: Phases of Research Process

Next subchapters describe in more detail the most relevant phases of the research process.

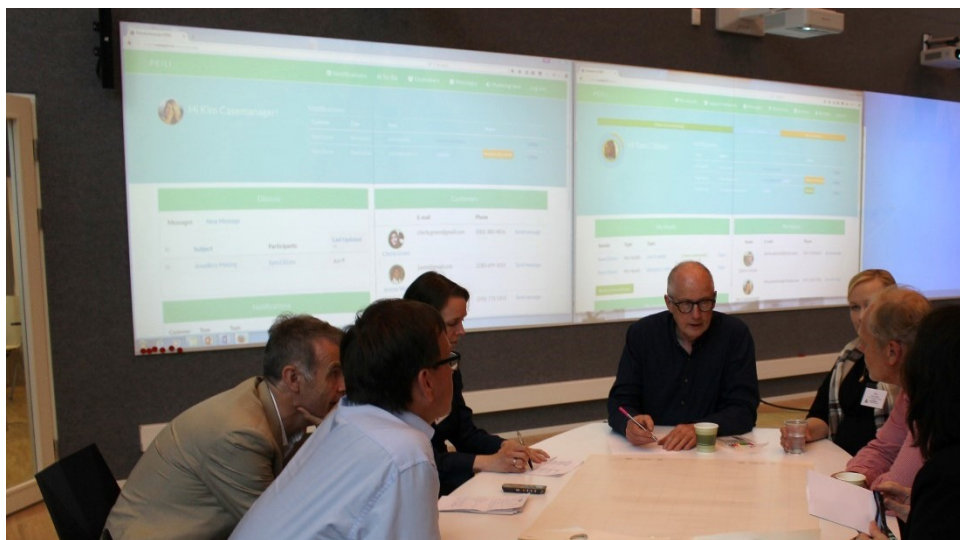
3.2.3 Seminar

MORFEUS-seminar was held from June 15th to 16th, 2016. The first day of the seminar consisted of presentations from different speakers and short Q&A and discussion sessions after the presentations. During the first day of the seminar, the MORFEUS-project and its results by that date as well as Peili were introduced to participants. The first half of the second seminar day consisted of presentations, similarly to the first day.

The participants of the seminar were experts of various relevant fields, such as healthcare, eHealth, social care, business, case management, IT, simplification, and law. Some of the participants gave presentations related to their fields. Also, the research team participated the seminar. The second half of the second day of the seminar focused on the prototyping workshop during which participants co-created knowledge relevant for co-designing a service. The workshop is described in detail in the next subchapter.

3.2.4 Workshop

The research focus of this thesis is the role of boundary objects in knowledge co-creation relevant for service co-design during this workshop. Peili – that was introduced to seminar participants earlier during the seminar – acted as a boundary object in the workshop and is therefore described in this thesis. As seen in the *Picture 3*, Dashboard views of both customer and case manager interfaces were projected onto the wall during the workshop. The goal of the workshop was to co-design a wellbeing service – and co-create various ideas related to it – to answer the similar needs for which Peili had been developed. The workshop task instructions are described in detail in the next subchapter.



Picture 3: Peili used as boundary object by projecting it onto wall during workshop

3.2.4.1 Workshop Teams and Tasks

During the workshop, participants were divided into three teams – of which two are observed in this study* – and each team was given a specific task. One team’s task was to discuss and create ideas how the digital (healthcare, social care, wellbeing) service should be and look like from the perspective of customer or patient. The other team’s task was otherwise the same, but from the perspective of case manager or other social care, healthcare, or wellbeing field professional. Teams were instructed to draw and write their ideas on big sheets of paper (posters). The duration of these workshop tasks was about 90 minutes.

The workshop was facilitated by two facilitators who were professional information visualizers with the expertise areas of knowledge simplification and information design. At the beginning of the workshop, the facilitators gave instructions of the tasks to teams. Facilitators also encouraged participants to be creative and not limit their thinking to the current service prototype/boundary object Peili. This way, the boundary object would be challenged and would not inhibit collaboration in a way described by Levina (2005). Views of Peili’s user interface were projected on a big wall visible to participants during the team tasks (Pictures 1, 2 and 3).

More specifically, the instructions of the workshop were the following:

- to develop criteria for user interface

**Originally there were 3 teams but analysis of one team was excluded because audio recording failed*

- to evaluate current interfaces (of Peili), and
- to prototype new ideas by drawing them on posters.

Also, in these instructions some requirements were listed for the service to be co-designed: customer UI criteria and functionalities such as:

1. customer's ability to manage their own well-being,
2. reporting their situation,
3. accessing all their health-related information,
4. communicating with professionals, and
5. enabling self-reflection.

For the case manager UI, the instructed criteria were:

1. case manager's need to know everything,
2. information from a wide range of sources,
3. and collaboration with other professionals and collaboration with customers.

Moreover, the participants were instructed to develop both 'hard' criteria such as features that users need, and 'soft' criteria such as the look, feel and focus of the interface. Finally, the participants were instructed to prototype new ideas by sketching out their ideas for each user interface and by using the materials in front of them (big sheets of paper, marker pens and other drawing and writing equipment).

3.2.4.2 Workshop Participants

In total there were 15 participants involved in two workshop teams examined in this study. Of these participants, 13 were regular team members and two facilitators. Neither facilitator was a MORFEUS-researcher. Instead, the facilitators were external experts, who had prepared the workshop structure and instructions based on earlier conversations with MORFEUS-researchers. Participants had a wide range of expertise, and their most relevant expertise is summarized in *Table 1*. The table describes each participant in the workshop. Customer perspective team members are referred to as 'CU' and case manager, professional perspective team members are referred to as 'CM'. The customer team had five (5) members, of which one left during the workshop. The case manager team had eight (8) members or nine when including their facilitator. One case manager team member left during the workshop. Additionally, from

the other seven (7) members of the case manager team, two (2) were absent a significant portion of the time.

It is also noteworthy to mention, that some of the team members in both teams were MORFEUS-researchers who had developed PEILI. This likely influenced the knowledge co-creation process. The researchers were also the ones inventing the feature ideas of Peili during the development of Peili prototype in the months before the workshop. Therefore, the researchers had different perspective to Peili and its feature ideas than other workshop participants.

Table 1: Participants in Workshop

Code for Person	Team membership	Field(s) of expertise	MORFEUS-researcher?	Other notes
FA1	Facilitator	Simplification, information design	No	Facilitated case manager team
FA2	Facilitator	Simplification, information design	No	Facilitated both customer teams
CU1	Customer	IT, business	Yes	Author of this paper
CU2	Customer	Law, contracts	Yes	
CU3	Customer	eHealth	No	
CU4	Customer	Innovation, Business	No	Was present between 24-70min
CU5	Customer	Healthcare, social care, eHealth	No	Left during workshop at 61min
CM1	Case manager	Strategy, business (professor)	No	
CM2	Case manager	Healthcare, social care, eHealth, IT	No	Left during workshop at 61min
CM3	Case manager	Case management, Social care	No	
CM4	Case manager	Business, social care, healthcare	Yes	
CM5	Case manager	Contracts, contract simplification	No	
CM6	Case manager	Social care, case management	Yes	Was present only part of the time

CM7	Case manager	IT	Yes	Was present only part of the time
CM8	Case manager	Business, Knowledge management	Yes	

After the team task, all posters from all groups were put next to each other in a wall. Then each group presented their ideas to other participants. During and after these presentations different ideas were discussed. However, this end discussion part of the workshop is excluded from the scope of this study, because no new ideas were created during this phase. Consequently, the end discussion is less important when observing the knowledge co-creation process.

4 Empirical Findings

In this chapter, the empirical findings are presented in the following way: First, the total number and structure of ideas formed during the workshop are described. After that, the structure and formation process of three big, high-level ideas – each of which was drawn into its own poster – is described and analyzed in detail. In this analysis, pictures of relevant posters, figures of structure of ideas, figures of idea formation timeline, and relevant quotes with commentary directly from the discussion data are presented. Then Peili's influence on knowledge co-creation during the workshop is analyzed. Finally, the main empirical findings are summarized and the two workshop teams compared with each other.

4.1 Number and Structure of Ideas

In this analysis, only ideas drawn or written down on posters were counted as ideas. The structure of ideas was largely hierarchical, or systematic. This means that many ideas were connected to other ideas and 'child' ideas or 'parent' ideas of other ideas. The figures in next three subchapters demonstrate well the structure of three big, high-level ideas.

Therefore, the total number of ideas can be counted in several different ways: if each piece of low-level co-created knowledge is counted as a separated idea, then the number of ideas is high, whereas if only high-level concepts are counted, then the number of ideas is low. Depending on the way of counting, the total number of ideas was at most 69 and at least 10. The total number of ideas with different counting methods is presented in *Table 2*.

Table 2: Total Number of Ideas in both Teams

Method of counting ideas	Total Number of Ideas
All ideas	69
Only high- and mid-level ideas	29
Only high-level ideas	10

Pictures of each poster are shown in *Appendix 2*. The lists of Ideas in Posters are shown in *Appendix 3*. In addition, some posters are shown, and ideas related to those posters are discussed in the next three subchapters. Those subchapters describe and analyze in detail the formation process of three high-level ideas.

The three high-level ideas were chosen for such analysis, because they all were high-level ideas, that had many lower-level ideas connected to them. Also, each of these three ideas was drawn on its separate poster in such way that all ideas on that poster are connected to that idea. In addition, all these three ideas and their posters represent actual user interface views, whereas some other ideas (that are not analyzed in detail in this study) were for example just written as list of words on a poster instead of drawing user interface views related to them. Consequently, the three ideas analyzed in detail were likely more relevant for the service co-design process than fragmented separate ideas that were not drawn. Also, by analyzing these three ideas, it is possible to analyze the formation process of the idea itself, ideas connected to it, and how and when the idea and the ideas connected to it were drawn on their separate poster.

4.2 Idea: Holistic View of Client's Life Situation (Case Manager Team)

This subchapter is about the first one of the three high-level ideas analyzed in detail in this study: *Holistic view of client's life situation*. Originally the idea *Overall view of client's life situation* was invented and visualized in *Poster 5* by the case manager team.



Poster 5: Holistic view of client's life situation (Case manager team)

The idea was about a Holistic view of customer's life situation. It is a user interface view where the case manager could see in visual way the most important aspects of different life areas of the client and see all these areas simultaneously. These areas were: Positives (positive things in customer's life), such as Job and Hobbies; Family (including relatives); Friends; Daily needs such as Housing, Car or transport and Money; Health, including Strengths (factors that support the health of that customer) such as Gym, (health) Problems, such as problems related to Alcohol and Dental; and finally Professionals helping me (the customer). The structure of this high-level idea is presented in *Figure 5*. The hierarchy of this idea consists of four levels: high-, mid-, low- and bottom-level.

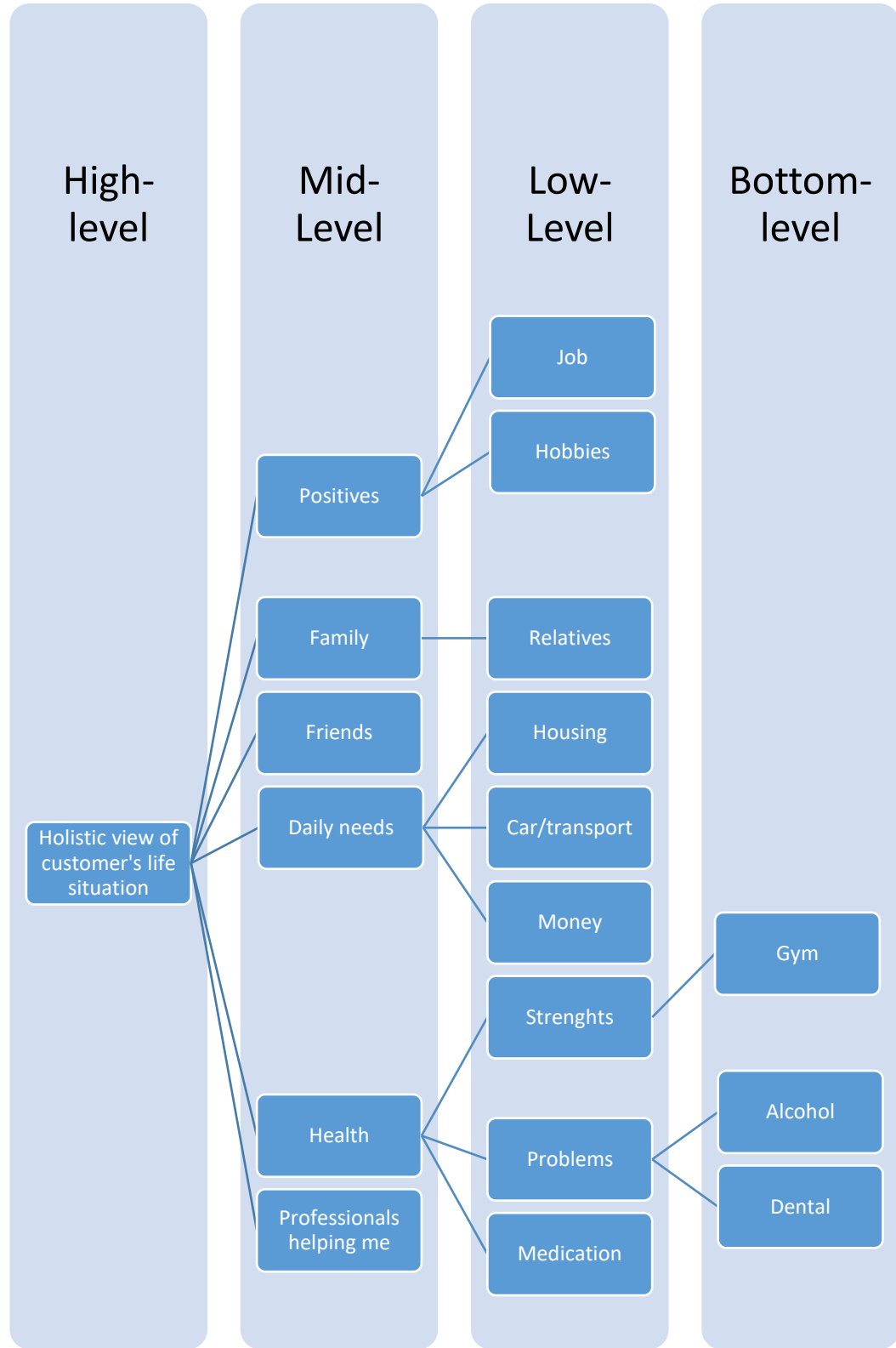


Figure 5: Structure of high-level idea 'Holistic view of client's life situation' (originally in Poster 5)

This idea – or some parts or versions of it – was discussed several times by case manager team participants. The details and meaning of this idea developed through the discussions. Some main points of the formation process timeline of this idea are summarized in *figure 6*.

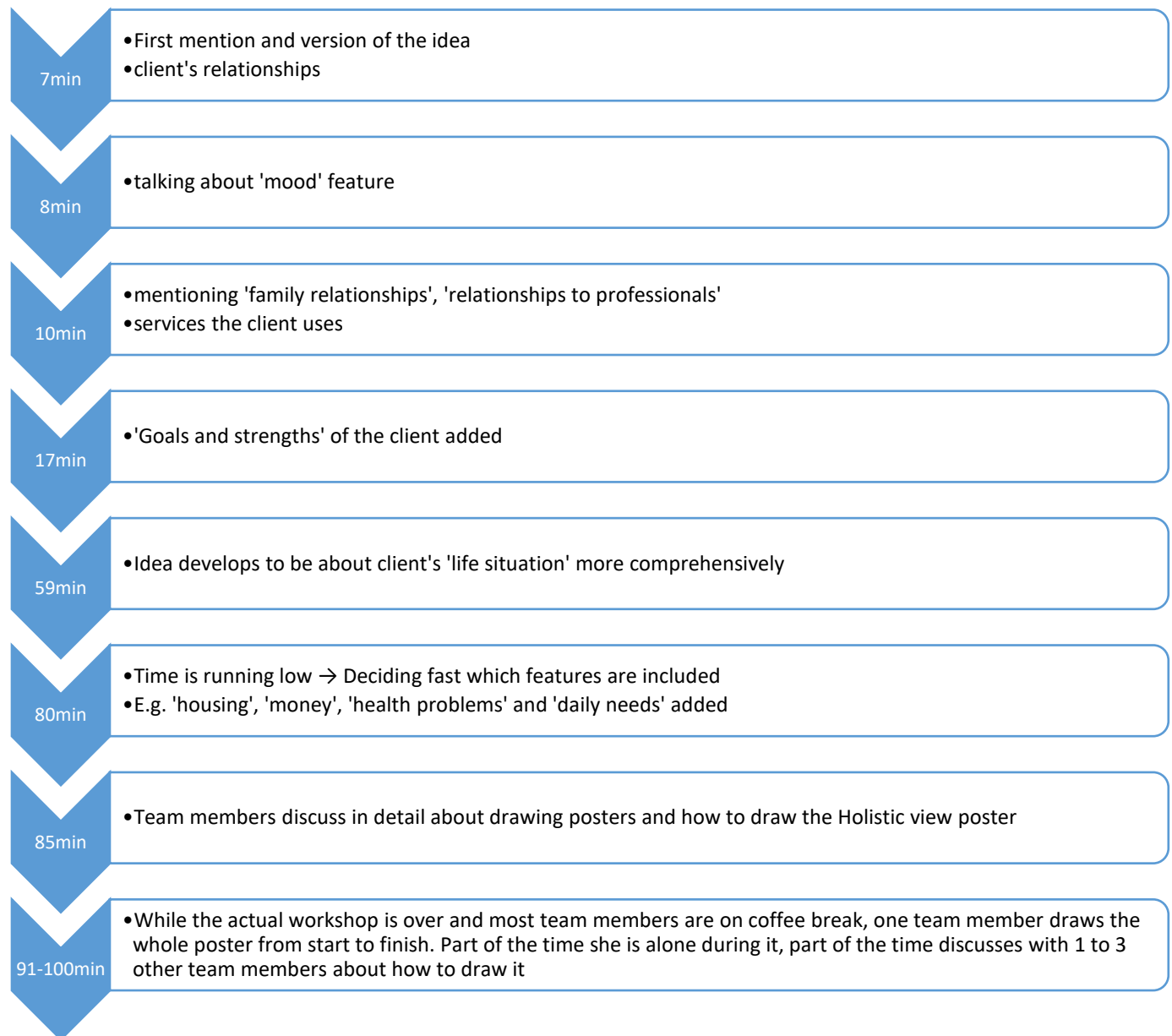


Figure 6: Formation Process Timeline of the 'Holistic view of client's life situation' idea

To get more detailed understanding about the idea formation process, it is necessary to look at some relevant quotes from the discussion. Some parts of the quotes are marked as question marks and workshop time within parenthesis (e.g. "[?? 00:59: 42]"), because that part was inaudible because of factors such as several speakers speaking simultaneously, ambiguous pronunciation and too quiet volume. Some of the most relevant parts – where an idea is mentioned or talked about – are bolded.

The first version of this idea was very different from the final version. At first the idea was only a 'holistic view' of client's relationships:

*FA1 [7min]: "Let's keep going with criteria, top-level criteria. Then we'll come back. We got the listing view, we've got access to customer choice, access to customer network, access to consents, **holistic view**. By **holistic**, is it all their relationships in their history..."*

Some discussion related to this idea followed immediately. About a minute later, including a 'mood' feature into the holistic view was suggested:

FA1 [8:30min]: "the holistic view needs to look at people's mood"

However, the conversation moved immediately to other topics and 'mood' was not included into the final poster. Soon, the idea progresses to include explicitly family relationships, relationships to professionals, and the services the client is using:

FA1 [10min]: I think what we meant was insight into the customer's view, who they relate to, who they chose not to relate to. Professionally, but also in terms of their network. Whether they have mother or sister or boyfriend or whoever that might be.

CM1: Or they have a GP (General practitioner) and a certain specialist

*FA1: Well there's the professional ones and the family ones. And do I access the consents they've given. **Holistic view** of the services they're getting. And how it's gone.*

*FA1: So you could say we're getting this many customers, this many interactions. If we are, the measure of success we set up for the **holistic view** would measure how many successful...*

A few minutes later, the goals and strengths of the client were added to the idea:

*CM5 [17min]: What particularly struck me: firstly, the need to work on strengths and goals. Secondly, changing the plan. Thirdly [inaudible]. And the strength to do that, it's always hard achieving these objectives. Don't we have to look how each of these elements is contributing to that? Measuring? We've got the customer network we already noted. **The goals and strengths** part of the holistic view then? Some case workers are better at treating customers with certain kind of strengths and helping to meet that certain goal. Correlations.*

FA1: I don't have any experience related to this, but wouldn't you then try to relate their service use to their goals.

CM3 Yes. I would do that or perhaps I would not do that if they don't need these services. Because people very often think the services are a good thing. But very often they are not a good thing.

Despite mentioning them, goals are not mentioned in the poster. After this, the holistic view idea or its features were not discussed in a long time – for about 40 minutes. Then, the idea of holistic view resurfaced and developed to be about client's whole life situation, instead of only relationships with professionals, family, and friends. Client's needs were added:

*CM1 [59min]: So, one of our questions is after we find out what they **need** that we're also gonna find out what they've already done. That's on our list somewhere.*

CM3 I think that's very important.

*CM1: And **whether they felt like they got their needs met or not.***

*FA1: This is a [?? 00:59:40] **view** [?? 00:59: 42] which is kind of this.*

*CM1: Yeah, but one is, our interpretation of our conversation with him and what they need, what **they say they need**, and us agreeing, these are the most important things. The other one is, what have you done in the past? Who have you interfaced with in the past and what were your experiences and were you satisfied or*

dissatisfied? You could reflect back on that. If they were satisfied with this GP or a specialist, then you might at a later meeting, ask if it would be okay.

FA1: I feel it's a little bit like in project management users who have an issues list of open issues and closed issues.

CM1: Oh, I like that.

FA1: You know, version control and things about what happened, who's next and...

*CM1: And you could have open issues, closed issues, and **unsatisfied needs** and something like that.*

*FA1: Yeah, and you could [?? 01:00:45] find a way of identifying your current **needs** which you think you've closed and then open up again. Interesting service. [?? 01:00:58] we've got the... the snapshot. Issues list.*

*CM1: What **you're calling the snapshot is your perception and their perception of what they need.***

*FA1: Exactly. That's **the holistic view of the network.***

*CM1: **Your current situation.***

*FA1: **State of need. That situation.***

The facilitator made often comments that interpreted the discussion of other team members as features in the user interface. About 20 minutes later the major characteristics of the holistic view were summarized by the facilitator. This is one example of how he regularly tried to discuss what feature ideas are put to which part of the interface. He tried to keep the team focused on the task given: to create feature ideas for user interfaces and put them on the posters:

*FA1 [79min]: ...We've got the individual view, so when you click on a person, this is **the situation, the holistic view, what their life is like, what they're accessing, what their network is.** We then got the case manager's work load overview. So, this when you've got... That doesn't just list people but also summarises more about...*

Then, as time was running short, the team started to quickly decide which features are part of the holistic view. Housing and money were added. Features were grouped into different categories such as health. Health problems was added. The 'daily needs' feature was added:

*FA1 [85min]: Various, we've almost got like... **family**.*

*CM1: **House**, one thing.*

*FA1: **Friends** area. We've got a **housing** area. This could be infrastructure, so in there've got housing, money.*

CM1: Electricity.

*FA1: Might be a **health summary**.*

CM4: Should we have the helper somewhere? Not about [?? 01:25:15], maybe under [?? 01:25:17] [laughs]

*FA1: So, this is people and this is **family**.*

*CM4: **Friends**.*

*FA1: **Network, professionals. Over here this is daily needs, maybe health...***

CM4: And maybe that's...

CM1: What is the difference between that and that?

*FA1: These are people. So, this person have probably **substance abuse**, a history of...*

*CM1: Okay, that's **problems** or?*

*FA1: **Problems yeah, health problems**.*

*CM1: **Health problems** okay.*

*FA1: **Not just health professionals, but professionals...***

CM1: Yeah, mostly health.

CM4: Maybe **his or her meaningful doing like hobbies and job and studies** and something.

CM1: Well that's not. That would be...

FA1: They're not problems.

CM1: No, but that's good because that's capturing some other aspects of their live.

CM4: Exactly.

FA1: That's true. So it could be they may have religious affiliations.

CM4: Exactly.

CM1: Yeah. So it would be...

CM4: And what they find valuable in their lives, so it can be...

CM1: Things that are **positive**.

CM3 Yes. **Strength**.

CM1: What to call that, though.

FA1: **Strengths** [?? 01:26:49]. We can call it [?? 01:26:55]. It doesn't work for it. We can think of [?? 01:27:02].

CM1: I don't know, it's kind of like **positive life choices** and you know what I mean, it's positive life choices. Might be religion, Facebook, what...

CM4: I think it's about activity.

FA1: Same as **friends**.

CM1: Now it's activities.

CM4: Is it **hobby** or are you going to...

FA1: Engagement.

CM1: Well that's it, but it's **positive** engagement with somebody.

Two minutes later, one team member (CM4) agreed to draw the Holistic view poster:

FA1: So, could you try to work that up?

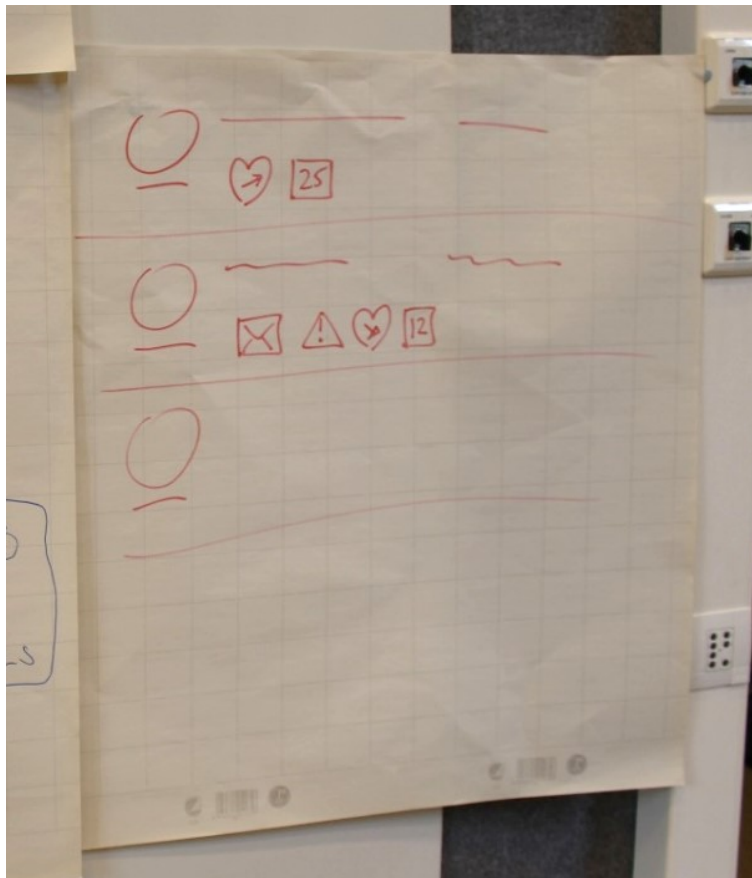
CM4: I'll try to do. Okay. And we had also that...

*FA1: That's something. That could be **one of the icons** that appears.*

A few minutes after the previous quote, she drew this idea on a poster in about ten minutes. She was part of the time alone while drawing it, and part of the time discussed with one to three other team members about how to draw it.

4.3 Idea: List of Clients (Case Manager Team)

Originally the idea *List of Clients* was invented and visualized in *Poster 6* by the case manager team.



Poster 6: List of clients with notifications (Case manager team)

The idea was about a List of clients with notifications. It was a user interface view where the case manager could see in visual way a list of relevant customers, and also immediately some other relevant information about these clients in the form of notification icons. So, the high-level idea was to have a user interface view of case manager's list of clients.

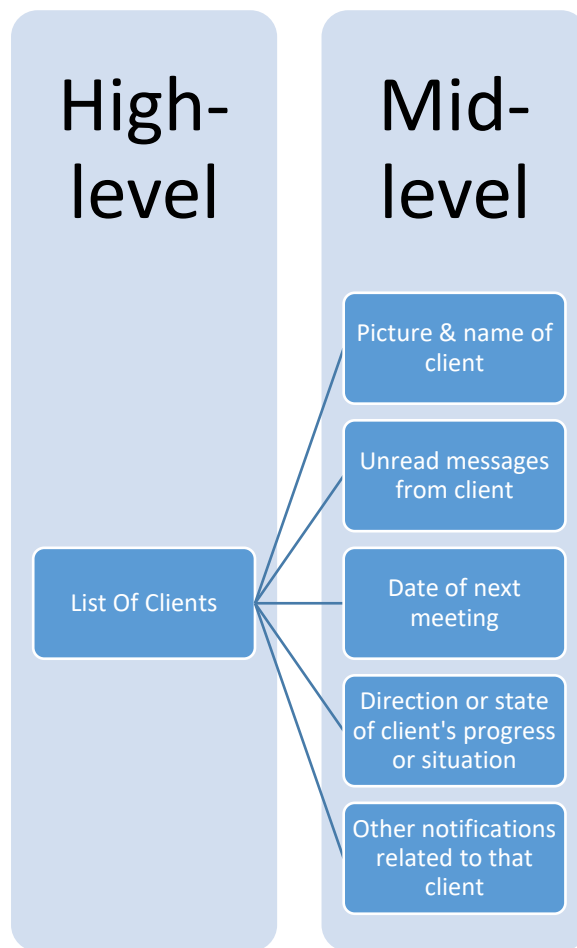


Figure 7: Structure of high-level idea 'List of Clients (originally in Poster 6)

Five lower-level ideas were connected to this idea: The first one was Picture and name of the client. The other four ideas were all different types of notification icons: an icon shown if there are Unread messages from that client; an icon showing the Date of next meeting with that client; an icon describing the direction or state of that client's progress or situation; and an icon or several icons for possible other important notifications (such as acute health problems) related to that client. The structure of this high-level idea is presented in *Figure 7*. The hierarchy of this idea consists of two levels: high- and mid-level.

Some main points of the formation process timeline of this idea are summarized in *figure 8*. Even though the idea was discussed many times – at the beginning, in the middle and at the end of the workshop – it was only drawn about 15 minutes after the workshop. It was drawn quickly in couple minutes, and alone by the facilitator of case manager team. Yet, the drawing captured many of the relevant ideas co-created by the whole case manager team.



Figure 8: Formation process timeline of the 'List of clients' idea

Next, to understand the formation process of this idea in more detailed way, some relevant quotes from the discussion are presented and commented.

This idea was mentioned first time almost immediately after the workshop began. Also, the related ideas of accessing customer data and having a tool for recording the interaction with a customer were mentioned:

*FA1 [2min]: But that's the customer view. We are now a case manager. **We have a list of customers.** I guess we have to know quite a lot about our customers' state of mind and...*

CM3 Yes.

*CM1: So we have to have access to **data available on customer.***

FA1: We want access to customers' state of mind, is that right?

CM3 Yes. Personal relation.

*CM1: You need **a tool to record the interaction with a customer.***

Some minutes later, the idea was mentioned again. The idea of consents was combined to this idea:

*CM2 [5min]: I completely agree. My point was very different. That I as case manager **have list of patients/customers.** And then I open one of them. Then I see what kind of **consents he or she has given.** The form how she or he gives them is different. Looking at the first screen today I know I'm going to deal with this person. And I know he don't want me to talk to someone or vice versa*

After that, terms 'listing view' and 'access to customer network' described as top-level criteria:

*FA1[8min]: Let's keep going with criteria, top-level criteria. Then we'll come back. We got **the listing view**, we've got access to customer choice, **access to customer network**, access to consents, holistic view...*

Then the list view was called 'work list' and 'my list of people'. Also, the idea of prioritizing clients was discussed:

CM3 [11min]: A very pragmatic point of view: I as case manager have several cases.

*So then actually **my first view is a work list**.*

*CM1: **My list of people**.*

*CM3 **My list of people, yes**.*

FA1: And my priorities.

CM3 Exactly.

FA1: What do I do today? Who's waiting for what?

*CM1: Which ones have more problems and therefore I'll have to change my caseload
or when I react to...*

CM3 So prioritization also...

Soon after, the idea was described this way:

*FA1 [13min]: ...then we've moved onto "**My work list**". **Who I'm dealing with, what my priorities are**. So, we've got a mix of mostly "hard features". The mood one is a soft feature.*

Then almost 40 minutes went by without any significant discussion about this idea. Finally, one participant suggested icons could be added to the client list:

*AR [53min]: The point is that you could have, could you not, say, these could all be **icons** and the green ones are the ones you're already in touch with, the gray ones are ones which simply exist, but you haven't contacted. There might be a no entry sign on one who says they haven't given you **consent**. They're in touch but you haven't consent to know any more.*

Soon after, there were lots of discussion and ideas related to icons and the client list:

FA1 [57min]: *I love the **icon idea**. So, you could always have **a list of clients** at four, your ten clients or whatever, you could have **icons which reflect the state of need or priority**... so, could even have the **date for the next appointment**. **A house icon because they've got a housing crisis**.*

CM1: *Yes, that's right. You could have some...*

FA1: *You know, **substance abuse icon**.*

CM1: *You could have **a packet of icons that could be brought up if they're relevant**, or not if they weren't. That way if it's **a bottle or a house or whatever**.*

FA1: *So, you're getting a visual. So, we should rather just have the name...*

CM4: *You used **colours** as example. Red is something...*

Then another perspective to the client list was suggested:

FA1 [60min]: *I feel it's a little bit like in **project management** users who have an issues list of open issues and closed issues.*

CM1: *Oh, I like that.*

FA1: *You know, version control and things about what happened, who's next and...*

Finally, when time was running out, and the team was intensively discussing about how to draw their posters, including the client list poster:

FA1 [88min]: *We then got the **workload overview**.*

CM1: *Oh my god, I got the green. You should help me.*

CM3 *Yeah, sure.*

CM4: *I think there already was one.*

FA1: *Well, no, it's just a list of things. Well two things. So the overview...*

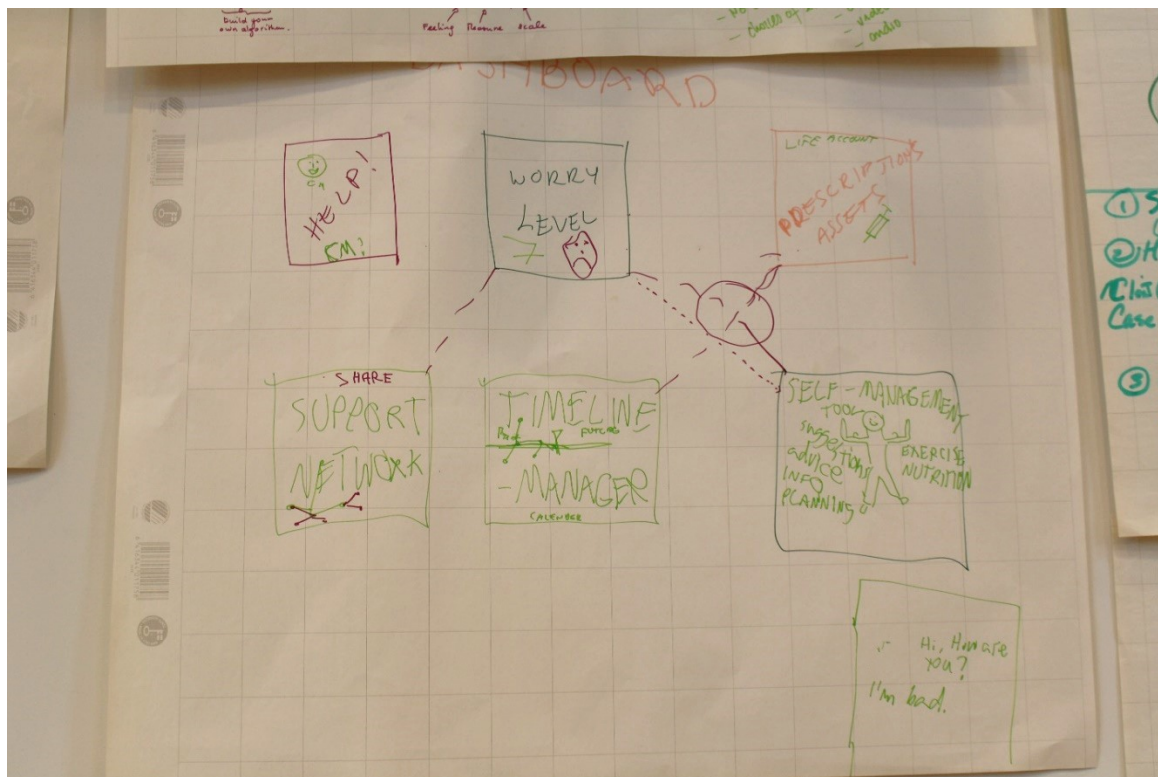
CM4: And **the to-do**. Make decisions. We were thinking about it if it was the point that we can **draw one patient here and then you can order them** or something like that

CM1: Okay.

About fifteen minutes after this discussion – while other team members were having coffee and socializing – the facilitator alone drew the List of clients idea.

4.4 Idea: Dashboard (Customer Team)

Originally the idea of *Dashboard* was invented and visualized in *Poster 2* by the customer team. Peili also has a dashboard that was projected onto the wall during the workshop. There are both differences and similarities to Peili in this idea (those are discussed in the next subchapter).



Poster 2: Dashboard (Customer team)

The idea was about a Dashboard view in the customer's user interface. It is a view where the customer could see in a visual way several different features – and some of the most important information related to those – of the service. The customer would be able to click any of these features to open a view with more details and information related to that feature. So, the high-level idea was the dashboard itself. Seven mid-level ideas were directly connected to this idea:

1. a Help-button, which would be an easy way to contact the case manager or other person that can help;
2. Inputting and tracking customer's worry level (from 0 or 1 to 10);
3. List of client's prescriptions and other similar medical data;
4. Support network of the client, consisting of close people such as professionals, friends or family that could potentially help that person;
5. A Timeline showing important events related to that client, such as future or past therapy sessions, meetings with case manager or other professionals, achievements and goals, and feedback or information about a session;
6. a Self-management tool that could help client to take initiative in tracking and improving one's health. The low-level feature ideas related to this tool were Suggestions for that client, advice, information, planning, exercise, and nutrition.
7. a Chat feature where the client could potentially chat in real time related to one's situation or problems. The low-level ideas and details related to the chat idea were the someone saying "Hi, How are you?" to the client and the client responding "I'm bad."

To summarize, this Dashboard idea had quite complex structure and formation process when including the lower-level ideas and their formation to the analysis of this idea. The structure of this high-level idea is presented in *Figure 9*. The hierarchy of this idea consists of three levels: high-, mid- and low-level.

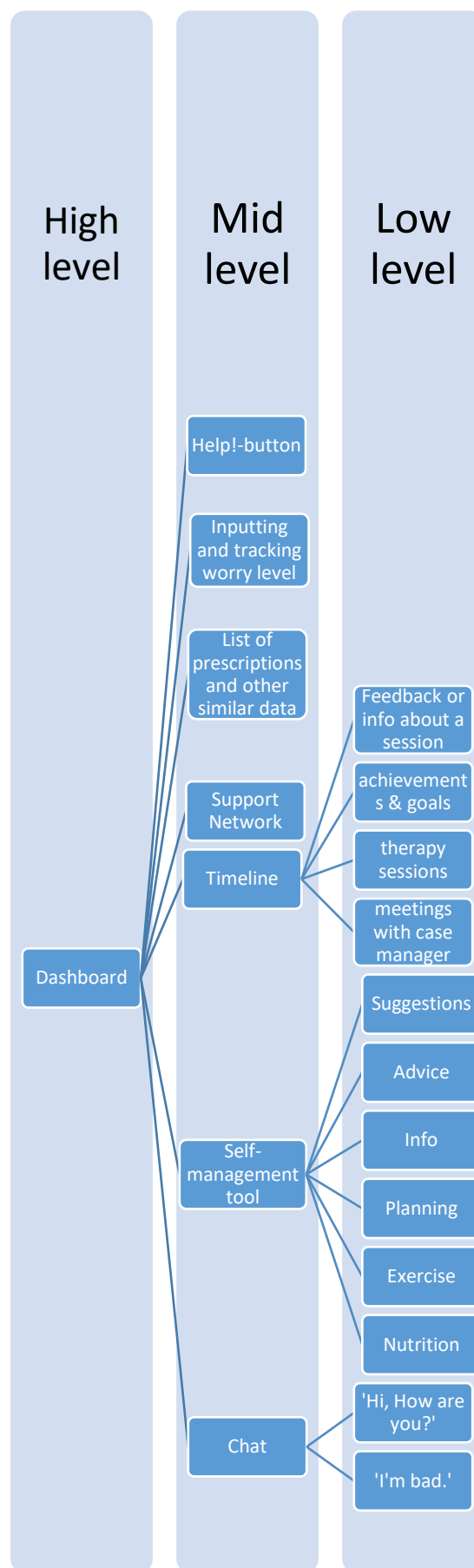


Figure 9: Structure of high-level idea 'Dashboard' (originally in poster 2)

The Formation process timeline of the 'dashboard' idea and poster is presented in *Figure 10* on the next page. The idea was mentioned already early. Then, the idea and various details related to it were mentioned and discussed many times at all points of the workshop. Finally, the drawing of this idea started when there was about 20 minutes left, and it was already mostly drawn when there was 10 minutes left. After it was at least mostly drawn, team members started using it aid their communication about complex features of the service.



Figure 10: Formation process timeline of the 'dashboard' idea and poster

Next, to understand the formation process of this idea in more detailed way, some relevant quotes from the discussion are presented and commented

The first mention and conversation about dashboard happened after 12 minutes. Also, laboratory results, on-going medication, and reminders – all features relevant for at least ‘prescription’ feature in the final dashboard poster – were mentioned:

*CU5 [12min]: We tried to design a software for cheap peas in this way, and I have talked in different software companies that how I would like to see first page in my software, and nobody has done it. They said the very simple thing: **I want to see about the patient who’s coming to my appointment all relevant data in one screen.***

*And no one has done it. It’s very simple how you can do it. **Your last laboratory results, on-going medication, reminders.** I don’t need to go deeply in every appointment notes because there is no important data. I need most relevant data.*

*CU3: **We used to call it dashboard. The dashboard, it just gives you numbers or some picture.***

CU5: Then you can go more inside.

CU3: Then you click on that, you’re right, then you go to that.

*CU5: **Dashboard is good** because dashboard is also...*

Soon later, the help feature of dashboard was mentioned and discussed for the first time. Also ‘self-reflection tool’, similar concept to ‘self-management tool’ in the final poster, was already mentioned:

*CU2 [14min]: Is that the kind, I mean, you have a few points. If it would be that here I get some **help**. That would be the kind of gateway to something. Then there might be even one of the first page things first, the telephone number where I can get the person, a connection to someone 24/7.*

CU5: Why you need the telephone number? You just have a picture of the person who want to contact you. You just click it.

CU2: Whatever. I mean so that you can have contact to someone if you are desperate, going to jump down the roof, so that you can push or whatever and you

*get someone's help, and then also if you get some kind of, this is kind of urgent, but in another situation that you could have some kind of possibility to have a **self-reflection tool**. These were some of the things which have been talked about, so that's why I through them here, and also the first page has been important. What would be the first page for a client, for a doctor, the kind you described would probably be a very good one, but for this kind of client who maybe it probably needs to be a bit different. Tempting, securing, comforting.*

CU3: Yes.

After mentioning 'self-reflection tool', 'self-care' was mentioned, but that idea was not supported by others:

*CU1 [17min]: What kind of interfaces could work for those people in most needs with most problems who for whom traditionally **self-care** doesn't work because their situation is so bad? Would it be possible to make some very easy-to-use, encouraging...*

*CU5: I think this kind of thing, **this is not self-care. It's a tool of communication.***

CU3: Exactly.

*CU5: Between the main users. Self-care is just like one procedure or one intervention. How it is delivered? **Main task of this kind of software is communication** between caregivers, the programmes, the services, and the person. So I think the self-care or it's not...*

*CU3: **You're not measuring yourself.***

Then, an idea similar to the timeline feature in the poster was mentioned within about two-minute-long monologue. Parts of that monologue were less relevant, so the next quote shows the most relevant parts of that monologue. Also, the idea of contacting somebody if something is wrong (like Help and Support Network features in the poster) was mentioned, although not directly suggested as a dashboard feature. Moreover, ideas of patients 'putting their feelings and problems to the website' and 'call or having a chat' were mentioned:

CU5 [18min]: ...**treatment plan** somehow simply **in calendar view**, what you should do today or tomorrow, what time you should take the medication...

If the measurement is out of range or **something is wrong**, **then** it is shown in red and **ask, do you want to contact somebody** and discuss this.

Some message to your caregiver or case manager that this is the problem and this person has the problem...

...(patients) **can put their feelings and problems to this website**, and now the caregiver, who is the case manager, will open the web and see that these persons have reported some severe problems. They are prioritised in the first order to deal with them and you can **call or have a chat** with them.

That monologue resulted to discussion about worry. Measuring worry from 0 to 100 was discussed (in the poster worry meter from 0 to 10):

CU3 [20min]: We were talking about **worry**. How do you think **someone could put their worries in such an interface**? Can you rank it? Can you have something, I feel bad today or very good. How do you get that information?

CU5: I think that we created this workshop clinic data flow and service flows. We also started with problem of **worry**...

...So **you have to have some scale**. Somehow **measure** what you can compare. The best thing is to compare your personal rankings in dynamics. **Is their worry higher than yesterday**? Is it so bad today that you want to die? You can put **from 0 to 100**...

...**Worry** could be also positive, so it's not always negative.

CU3: Depends on the **strength of the worry**.

CU5: Yes. So you have to look the worry from different dimension, so you can clarify the next step.

About 20 minutes later, the timeline feature (in the poster) was mentioned:

*CU4 [38min]: what would be the meaning of the **dashboard** or any kind of system, it seems like to be able **to contact somebody. To make an appointment** somewhere. Okay. [?? 00:38:41] call something. It can be **data summary**. So it can be okay now you I don't know, some kind of summary. Okay, **you have met this and this, and maybe an event or a reminder** okay **your next appointment** with chiropractor is...*

*CU5: It's **like calendar**.*

*CU3: Like a calendar, and you had a **timeline** before.*

Then, the facilitator interpreted the conversation of the team as specific ideas. She also suggested a 'journey' feature that resembled the timeline idea:

*FA2 [41min]: To me you've got at least **three big ideas**. You've got the dashboard, the **personalised dashboard** thing, you've got **some sort of really interesting journey, it's more than a timeline**. It's a journey more than a guideline, and I don't know how you should present that, but that could be very interesting. But you could scroll forward in that **journey** if you wanted to.*

'Chat' discussed the first time explicitly as potential dashboard feature:

*CU4 [51min]: It should be as a part of the service delivery that you can make different choices, is it physical, oral, **chat**.*

FA2: So that's part of your customised dashboard.

*CU4: It's the next step, if you pick up some service or if you need some intervention, then you should have choice, is it physical, is it video consultation, is it **chat**, so that is already design of the service, but not platform as such. Platform is collaboration and getting together all these different...*

During the last third of the workshop, the team was starting to draw the Dashboard poster. Team realized they must decide what features to draw on the poster. Also, the 'chat' feature was mentioned in the same form as in the poster:

FA2 [64min]: The remaining sort of I suppose 40 minutes or so.

CU3: I need coffee.

FA2: We need a coffee, but also we're gonna need some screens.

CU1: Alright we need to draw something.

CU3: We can start dashboard. That's one picture. We just need to fill out what the four five of them are.

FA2: ...Yes, drawing.

CU3: I'll be back any second, get coffee. I just think maybe as we start with the dashboard, number 1, and we just need to define what these dashes are, what these [?? 01:05:01] are. It's a bit like a car. You have a [?? 01:05:05] on it's own, all the rest.

That's the concept of the dashboard.

*CU1: We could have **lower right corner a small chat window like on Facebook.***

[Influence of Peili]

CU3: An option.

CU1: Online store where you go and then there's this chat.

CU3: Do we need another piece of paper.

CU1: Yeah, let's take another.

*CU3: This one here. Pick it up. This one here. And then you're saying that we could always have some sort of chat in the. **Then you have to define 1, 2, 3, 4.***

CU1: That's also customisable which customer would have this.

Then, the team was quickly deciding most features of the Dashboard, interestingly just 5min after the most talkative and seemingly the most knowledgeable subject matter expert left:

CU3 [66min]: We have decided, we have 1, 2, 3, 4. For one of them we could say is how worried are we, the **worry intensity**. That is how you feel today. One of them like the **contact, quick call**. One of them can be **how you're feeling today, how worried**.

The another one is [?? 01:06:19] or something like that. You need to top up or something like that. We have to put it to words. We're talked very technical. Now when we think we go down this user thing, top up, and then 4, let's define what they are. So what are the service do you think they would need? It's good to have a running chat here.

CU2: We can **start by drawing that**.

CU3: So let's quickly say, what do you think these different services would be because one would be...

CU1: At least somewhere you should be able to put information that would **measure your worry level**, at least partly based on your subjective information that you put, and then could be at least partly automated system, worst, people with highest worry score, maybe **chat would automatically someone would start talking to them**.

CU3: What I would say is exactly what I would say, this would be your friendly case study, this would be your worry score, so today it's 4.

CU3: If it's like **worry score**, it'll be like today you're 4. But you can click on that to change. Today I'm really bad, so it comes at an 8, or I'm really good, that's 1. **So one is worry. This one would be prescription or medication** or something like that.

[referring to poster]

CU2: You can't remember those...

CU3: But one of them is your **timeline**, that'd be the last one. This thing here. The things you put on that and that opens it up. I was thinking. So, he can draw them quickly because they have to have a thing. So **first one is contacts, second one is worries, third one is medication or support or resources, last one would be timeline**.

Anything that we've missed? I guess family or contacts. I don't know. They talk about family networks. All of these things are supporting.

*CU1: Of course, **one could be some kind of notifications or messages**, either from your **support network**, either your friends or family or some professional. CU3: You can you yeah **an icon for network then** and that could be like you said. **First one is contact, second one is worry, this one is top up, whatever, this one is network, and then last one would be your timeline. Now you've got those, and you can draw different.***

Then, once the most major features were decided, the team's focus moved onto confirming and drawing features of dashboard, deciding details related to feature visualizing, for example a smiley and a number 7 for worry score. This part of discussion happened partly in Finnish because the non-Finnish speaking participants were not present (e.g. getting a cup of coffee) all the time. Due to its length, this quote is in *Appendix 5*, under title *Quote 1*.

Then, after the poster was mostly drawn, the team decided and drew more details of features, discussed about drawn features and added the self-management tool feature. Due to its length, this quote is in *Appendix 5*, under title *Quote 2*.

Near the end of the workshop, some final additions were made to Dashboard poster. When discussing how the actual service would work, various parts of dashboard poster were repeatedly referred to. This way Dashboard poster makes communication about complex characteristics of the service more effective. Since features are drawn to the poster, a deep conversation – about exact ways these features would be used and how they are related to other parts of the service – emerges.

Also, a more detailed timeline is drawn on another poster, inspired by small timeline feature in dashboard. Due to its length, this quote is in *Appendix 5*, under title *Quote 3*.

4.5 Peili's Observable Influence on Knowledge Co-Creation

One part of the workshop instructions was to 'evaluate current interfaces', referring to the interfaces of Peili. Also, Peili's interfaces were shown and functionalities and purpose explained to participants earlier. Peili's main user interface views were projected onto walls during the workshop. Therefore, Peili acted as the context of the workshop.

Otherwise, Peili's influence on the knowledge co-creation process can be observed from several factors. Firstly, direct, or indirect mentions of Peili in workshop discussions can be a sign of its influence. Secondly, similarities and differences between Peili and ideas in the posters give understanding about Peili's influence in knowledge co-creation process.

Direct references to Peili were rare in the workshop discussions. For example, in 52 pages of discussion transcriptions the word 'Peili' is not mentioned even once. However, there were some occasions in the discussions of the case manager team, when a MORFEUS-researcher – the one who had had the largest role of all researchers in the development of Peili (he had programmed the prototype) – quite directly referred to Peili. He explained some Peili's current features and even showed Peili from computer. Some of these references are shown in detail in *Appendix 4*. Also, in video recordings there are a few occasions where some team members pointed and commented parts of Peili's user interface projected onto the wall.

To understand how similar or different the ideas in the workshop were to Peili, it is adequate to look which of the ideas (or similar ideas to them) in the three posters analyzed in chapter 4 were also in Peili. These similarities are listed in *Table 3*.

Table 3: Similarities in the three posters compared to Peili

Idea name (features significantly new compared to Peili in bold)	Poster of Idea	Team	Included in Peili? (Yes in bold)	Similar feature in Peili?
Dashboard	Dashboard	Customer	Yes	
Help	Dashboard	Customer	No	
Worry level	Dashboard	Customer	No	
Prescriptions (& other medical data)	Dashboard	Customer	Yes	

Support network	Dashboard	Customer	Yes	
Timeline	Dashboard	Customer	Yes	
Self-management tool	Dashboard	Customer	No	
List view of clients	List view of clients	Case manager	Yes	
Notification icons	List view of clients	Case manager	No	
Unread messages icon	List view of clients	Case manager	No	
Date of next meeting icon	List view of clients	Case manager	No	
Progress or direction icon	List view of clients	Case manager	No	
Other important notifications icon	List view of clients	Case manager	No	
Holistic view of client's life situation	Holistic view of client's life situation	Case manager	No	
Professionals helping me	Holistic view of client's life situation	Case manager	Yes	'My Helpers'
Medication	Holistic view of client's life situation	Case manager	Yes	'Prescriptions'
Strengths	Holistic view of client's life situation	Case manager	Somewhat	'Pillars'
Positives	Holistic view of client's life situation	Case manager	Somewhat	'Pillars'
Daily needs	Holistic view of client's life situation	Case manager	No	
Housing	Holistic view of client's life situation	Case manager	Somewhat	'Housing support' under 'My applications'
Money	Holistic view of client's life situation	Case manager	Somewhat	'Unemployment support' under 'My applications'
Car or transport	Holistic view of client's life situation	Case manager	No	
Family	Holistic view of client's life situation	Case manager	Somewhat	'My helpers' and 'Support Network' in Peili customer view
Friends	Holistic view of client's life situation	Case manager	Somewhat	'My helpers' and 'Support Network' in Peili customer view

The three posters analyzed in this chapter had 24 features in total. Seven (7) of them are also in Peili in similar form or name. In addition to those seven features, 6 features are in Peili in somewhat similar form or name. So, in total, out of 24 feature ideas in posters, 13 are the same or somewhat same as the ones in Peili. In other words, over half of the features in related to the three top level ideas in the three posters were similar to Peili's features. That is a significant degree of similarity. However, there were also eleven (11) feature ideas in these posters that were not in Peili.

4.6 Summary of Findings and Comparison of Teams

There were both similarities and differences between the two workshop teams and how they co-created knowledge and draw it on posters. Both teams mostly draw their posters late, not before the last 15 to 30 minutes of the ~90-minute workshop.

In the case manager team, the posters were drawn very late: drawing them was left as the last thing the team did. All posters of case manager team were drawn after the actual workshop had already ended. Each poster was drawn by a single person, the List of Clients poster in a couple minutes by the facilitator of the team alone. The Holistic view poster was also drawn by another single team member, but part of the time during the drawing she discussed with some other team members about its details. The third poster by that team was drawn by another single team member in similar manner to the Holistic view poster.

Consequently, there was not significantly time left to discuss within case manager team after the feature ideas were drawn. Perhaps because of this (lack of time), a significant portion of feature ideas of case manager team that were mentioned in the conversation were not drawn or written onto posters, even though the individuals who drew the posters took carefully into account ideas discussed during the workshop and seemingly tried to draw their posters based on those co-created ideas. Also because of drawing the posters so late, in the case manager team the drawn posters did not effectively improve communication during this workshop, because there simply was not time left to discuss.

In the customer team, the posters were drawn also mostly during the last third of the workshop, especially the Dashboard and Timeline posters. Yet, they were drawn earlier than in the other team. Thus, the customer team had still about 15 minutes left when their posters were already mostly drawn. During these 15 minutes, the team members started to talk about complex functionalities – more complex than just the features drawn on the posters – while actively referring to various parts of the posters. In other words, the posters helped to communicate more complex thoughts about how the actual service would work.

Because the drawn posters seemed to improve communication, mutual understanding and the whole service co-design activity, the service co-design output from the workshop would likely have been better if there was more time to discuss within teams after drawing the posters. This could have led to better and more complex ideas and clearer, deeper vision of how the service should look and function.

Another interesting finding was that in both teams the person with likely the deepest relevant knowledge had longest comments and spent more time than anyone else speaking. In the case manager team this person was the only participant who is a professional case manager. In the customer team, this person was a medical doctor with deep relevant knowledge about healthcare, eHealth and IT-platforms in healthcare. His longest single monologue was four (4) minutes long and he had several about two (2) or three (3) minutes long comments. He shared lots of interesting, seemingly relevant knowledge. But interestingly, after he left during the workshop, the team almost immediately started focusing on deciding which features to draw and drawing them on the posters. In the case manager team, the knowledgeable and talkative participant stayed the whole duration of the workshop, and perhaps partly because of that this group did most of their drawing at the last possible moment. Funnily, that person even kept his coffee mug and plate on top of the empty posters, which made it even more difficult to start drawing posters.

Moreover, in both teams, conversations went much deeper than just listing feature ideas. Among other things, there were long stories, monologues and explanations about how various real-life services and processes work and could or should work. Therefore, features listed in posters do not necessarily capture nearly all insight in conversations. They rather summarize some of the relevant points. However, at least some of this deeper understanding was helpful for figuring out the best possible features for these posters.

There was a significant difference between the roles the facilitators took in each team. The facilitator of customer team was present less than half of the time, because she also facilitated the third team (that

was excluded from this study). At the beginning, she spent about 10 minutes with the team instructing them and helping them to get started. After that, she was occasionally present at the customer team and typically then asked questions related to team's progress related to the workshop assignment. She also otherwise tried to improve team's focus on the assignment, for example by encouraging the team to draw their ideas. The role she took as a facilitator seems like a typical facilitator behavior.

On the other hand, the facilitator of case manager team was present in the team the whole duration of the workshop. Similarly to the facilitator of the customer team, he also did some typical facilitator actions. At the beginning of the team task, he instructed the team and helped them to get started. He also often tried to interpret comments by other team members as feature ideas. He seemed to be focused on the team task and tried to keep other team members focused too. Yet, otherwise his behavior was largely typical – non-facilitator – team member behavior. Just like other team members, he actively participated on all kinds of discussions and knowledge co-creation. He also contributed his own service related ideas, which is not the most typical facilitator behavior.

5 Results

In this chapter the results of the study are presented. The key empirical findings (Chapter 4) are discussed and looked from a theoretical perspective (Chapter 2).

In the empirical part of this study, there were two types of boundary objects. The first was Peili: a digital service prototype. The second type of boundary objects were the posters that participants co-created during the workshop. The role of these boundary objects in the knowledge co-creation process – especially the idea formation process – during the service co-design workshop is discussed in this chapter.

Based on theory, both Peili and posters clearly were boundary objects, since both acted as catalysts for knowledge co-creation (Paavola & Hakkarainen, 2005). In addition, posters were used as aggregator of knowledge co-creation (Pöyry-Lassila et al., 2013), because teams drew some of the most important co-created knowledge on them. Peili and posters also helped participants – that had different backgrounds – to communicate and collaborate better, as described as important characteristics for boundary objects by Star and Griesemer (1989).

The context for knowledge co-creation in this study was a service co-design workshop. The participants had diverse backgrounds forming what may be considered as *innovative knowledge community* (Smeds & Pöyry-Lassila, 2011). The setting of this study was in many ways like the settings of the studies by Smeds & Pöyry-Lassila (2011) and Pöyry-Lassila et al. (2013). Therefore, these studies are relevant theory when analyzing this study from a theoretical perspective.

5.1 Role of Boundary Object (Peili)

Peili was a predesigned boundary object that was used during the workshop. Even though the workshop task was not to directly develop Peili into something better, the assignment was to co-create ideas and knowledge for a service quite similar to Peili: a digital well-being and healthcare related service platform where customers and case managers could see various information and communicate. Consequently, when looking Peili's role as boundary object through the four contextual factors that affect the way objects are used in co-development (Pöyry-Lassila et al., 2013), Peili's role was to act as object that was evaluated and that acted as starting point for the co-creation of new service co-design thoughts and ideas.

Peili was also an external representation described by Blomkvist & Segelström (2014). They describe two beneficial types of external presentations for service design: visualizations and prototypes. Peili was a visual prototype, which makes it likely an effective boundary object for service (co-)design. (Blomkvist & Segelström, 2014)

The similarities between Peili and the co-created ideas – such as dashboards by both teams and in Peili – provide empirical evidence of Peili's influence on the knowledge co-creation. It is highly unlikely that participants would co-design services that resemble so much Peili, if Peili was not shown to them before or during the workshop. Therefore, Peili seems to have influenced the knowledge co-creation and the whole service co-design process by acting as its context.

Another likely reason the co-creations of workshop teams resembled Peili so much is that several MORFEUS-researchers, who had been involved in the development of Peili, were also workshop team members. However, this reason by itself explains only a minority of the similarities, since most feature ideas were suggested by people who were not MORFEUS-researchers. Yet, there was also a significant difference between Peili and co-created ideas, which indicates that Peili as boundary object was not left unchallenged and therefore did not inhibit collaboration in a way described by Levina (2005) or limit the service co-design activity strictly to systems very similar to Peili.

Peili seems to have framed participants' thinking so that they were able to have common enough vision about what they are trying to co-design. Peili appears to have supported translating between different viewpoints and consequently helped people with different backgrounds and expertise to better understand each other and collaborate (Star & Griesemer, 1989). When interpreting Pirinen's (2016) theory, Peili acted as boundary object that supported collaboration and finding common ground. Consequently, Peili was an enabler for co-design of the service. (Pirinen, 2016)

5.2 Role of Boundary Object (Posters)

In this subchapter, the role of these posters in knowledge co-creation during the service co-design workshop – especially in the idea formation process – is analyzed.

In addition to Peili, the posters – on which team members co-created knowledge – are boundary objects. However, the posters are different type of boundary objects than Peili. Unlike Peili – that was created

already before the workshop by MORFEUS-researchers – the posters were co-created during the workshop collaboratively by workshop participants. Two essential roles for boundary objects are: (1) they can be objects that are collaboratively created but also (2) serve as catalysts for the co-creation process (Paavola & Hakkarainen, 2005). The posters had both roles whereas Peili only had the role (2) (serving as catalyst for the co-creation process). In other words, the posters were ‘shared objects of activity’ which were developed collaboratively. Otherwise too, the role of posters highly resembles the role of (boundary) objects in theory of knowledge creation as part of trialogical learning. For example, in trialogical learning novel ideas form through interaction between individuals and objects – just as they did in the workshop of this study. Another relevant characteristic of knowledge creation through trialogical learning is sustained pursuit of knowledge advancement. The purpose for posters was to advance knowledge related to the service on which the workshop focused. (Paavola & Hakkarainen, 2005; Hakkarainen & Paavola, 2009)

Another theory concept relevant to the role of posters as boundary objects is knowledge building by Bereiter (2002). In knowledge building ideas – conceptual artefacts – act both as outcomes of knowledge co-creation and as tools for reaching those outcomes. Therefore, posters and ideas drawn on them acted as boundary objects for knowledge co-creation similarly to how Bereiter’s conceptual artefacts act in knowledge building.

During the team discussions, there were many ideas that were talked about even several times but were never written or drawn on a poster. For example, the case manager team discussed several times about customer choice and the importance of the permission of a customer. This led to the idea of ‘customer consent management’ feature, but it was never written on posters. So, many of the ideas in the conversation were written on the posters, but not nearly all of them. This relates to findings of Levina (2005): it is necessary for participants to actively use a boundary object to realize benefits from it. On the other hand, using the previous example, the case manager team seemed to reach the agreement that such consent management system should be embedded into the service, even if it was not visible directly in the user interface views drawn on the posters. Therefore, the posters can be seen as the tip of the iceberg of knowledge created during the workshop: the most visible knowledge created, but not nearly everything that was discussed about.

The knowledge or ideas mentioned in conversation but not written on posters can be seen to some degree as articulating tacit knowledge into explicit knowledge – as described by Nonaka (1995, 2000). According to Nonaka, such articulating of tacit knowledge is one form of knowledge creation – ‘externalisation’. Also,

drawing or writing knowledge on posters was knowledge creation through externalization. In addition, discussing these ideas and drawing them on posters collaboratively can be seen as knowledge connecting and combination processes. It seems that posters helped to externalize tacit knowledge and make explicit knowledge more crystallized than discussing without posters would have. Therefore, posters supported the externalization and connecting processes and that way helped knowledge co-creation. (Nonaka, 1995; Nonaka, 2000)

The posters were beneficial in creating new ideas and specifying how they would look visually in user interface. Already before drawing specific features on posters, the mere intention – because it was given as the workshop task – to draw them seemed to improve teams' focus and efficiency in co-creating those feature ideas. According to Nicolini, Mengis and Swan (2012) objects in cross-disciplinary collaboration motivate collaboration. This seems like a reasonable explanation that at least partly explains the more focused and effective collaboration because of intention to draw on posters.

One example of this is that when there was not much time left anymore – so there was a hurry to draw something on posters – suddenly teams' focus and productivity in creating those feature ideas increased. In some cases, many feature ideas were created and decided during just a few minutes, just before drawing them. This also indicates that lack of time acted as motivator that improved knowledge co-creation productivity. Theory related directly to creativity and how time pressure influences productivity in creative pursuits such as idea formation may be relevant to understand better the role of lack of time as motivator (e.g. Basadur, 1991; Chirumbolo et al., 2004; Blair & Mumford, 2007). However, such theory is out of the scope of this study and therefore not explored further here.

The mere team task – that created the need to co-create posters – seems to have improved the focus of this team – perhaps through motivating participants to collaborate in focused way (Nicolini, Mengis & Swan, 2012). Consequently, the posters seem to have improved the idea formation and the whole service co-design process in this team.

One empirical finding was that after the posters were completely or mostly drawn, the team members started to refer parts of posters in conversation in a way that seemed to help them to communicate more complex thoughts related to the service. This finding may be explained well by theory about how external visual representations – such as posters – enhance cognitive power (Kirsh, 2010). The posters seem to have accomplished this by several ways listed by Kirsh, such as:

- providing structures that can be used as shareable object of thought,

- reducing cognitive cost of sense making,
- being more natural representation of user interface than mental representation, and
- enabling constructing more complex structures. (Kirsh, 2010)

Also, the empirical findings about the role of drawn posters agree with the findings by Eppler and Burkhard (2007) about how ‘heuristic sketches’ – which are rough drawings just like the drawn posters of our study – can assist group reflection and communication process by making knowledge-in-progress explicit and debatable. Such drawings also are said to foster the creativity in groups. (Eppler & Burkhard, 2007)

That way, the (drawn) posters served as boundary objects that improved communication and mutual understanding between the participants. This was expected based on other relevant theory too. According to Pöyry-Lassila et al. (2013) such characteristics of boundary objects are important factors that influence on the way boundary objects are used in co-development workshops. Carlile (2004) also found boundary objects effective in new product development – a context quite similar to the service co-design workshop of this study.

The phenomena described in the empirical findings resemble some classic challenges for facilitators listed by Kaner (2014). One of them is domination by a highly verbal member to which encouraging other members to participate more may help. Another one is poor follow-through on assignments. In this study, most of the time teams did not necessarily focus on completing the workshop assignment: drawing service related ideas on posters. The solution suggested by Kaner sounds helpful: making teams report back the progress of their task already at the midpoint of the assignment duration. However, in the workshop the facilitators asked several times during the assignment the teams questions related to their progress – such as how they are progressing and what feature ideas they have and what they have drawn on. Therefore, even though Kaner’s advice is sound, in practice it can be difficult to ensure continuous high focus on knowledge co-creation task by participants. (Kaner, 2014)

Finally, the fourth relevant facilitation challenge in this study was ‘quibbling about trivial procedures’ (Kaner, 2014). In other words, often in their long monologues, the most knowledgeable experts focused a lot on details that were not necessarily relevant or important for the knowledge co-creation task. Even though the facilitators tried to keep teams focused on their task – deciding features of user interface and drawing them on posters – perhaps they could have responded more effectively to this challenge by making the teams step back from irrelevant details. An additional observation from the workshop is that – similarly to facilitators – some participants with less relevant subject matter expertise focused a lot on

deciding and drawing the features. Consequently, it ironically may have been the case that during some moments of the workshop, the least knowledgeable participants were most productive and the most knowledgeable experts least productive towards completing the knowledge co-creation assignment. (Kaner, 2014)

Therefore, it seems that although the most knowledgeable individuals are invaluable for this kind of knowledge co-creation in a service co-design workshop, it is important to channel their expertise in effective and focused manner towards completing the co-design task. Workshop facilitators have a crucial role in this. With proper actions by facilitators, the focus of such participant can be channeled more productively.

6 Conclusions

6.1 Answers to Research Questions

This subchapter answers first the two supportive research questions, and then based on them the main research question.

How did Peili as boundary object influence the knowledge co-creation when co-designing services during the workshop?

In the feature ideas of the teams, there were plenty of similarity to Peili, but also many differences. Also, a small number of references to Peili was made during the discussion.

These findings indicate that Peili acted as the context during the service co-design workshop, and that way it framed participants' thinking so that they were able to have common ground about what they are trying to co-design (Pirinen, 2016). Thus, Peili acted as an enabler of co-design of the service (Pirinen, 2016). The differences in feature ideas of the teams compared to Peili indicate that Peili as boundary object did not limit participants' thinking too strictly to services very similar to Peili (Levina, 2005). Peili was a visual service prototype, and as such an effective boundary object for service co-design (Blomkvist & Segelström, 2014).

How did posters as boundary objects influence the knowledge co-creation when co-designing services during the workshop?

The posters acted simultaneously two different ways described by Paavola and Hakkarainen: (1) they were objects that are collaboratively created – 'shared objects of activity' – and (2) they served as catalysts for the knowledge co-creation process (Paavola & Hakkarainen, 2005). When looking through the concept of knowledge building by Bereiter, the posters were conceptual artefacts that acted both as outcomes of knowledge co-creation and as tools for reaching those outcomes (Bereiter, 2002).

Furthermore, the act of drawing on posters was knowledge creation through externalization. Posters helped externalize tacit knowledge and make knowledge more crystallized than discussing without posters would have. Therefore, posters supported the externalization process and that way helped knowledge co-creation. (Nonaka, 1995; Nonaka, 2000)

The given workshop task to draw posters and consequently the effort to co-create posters with feature ideas for user interfaces increased the participants' focus and productivity in co-creating such ideas during the workshop. The more teams focused on drawing these posters, the higher their productivity in forming such ideas seemed to be. According to theory, objects in cross-disciplinary collaboration motivate collaboration (Nicolini, Mengis and Swan, 2012). This seems to explain the more focused and effective collaboration because of intention to draw on posters. Consequently, the posters improved knowledge co-creation and the whole service co-design process.

Another way how posters improved focus and helped co-creation of relevant knowledge was that posters acted as a 'parking lot' where ideas were saved (Kaner, 2014). This way, even when teams were discussing several different topics – including less relevant details – at the same time, the posters helped them co-create relevant knowledge and return to it. However, also time pressure and repeated reminders by workshop facilitators seemed to be necessary to keep teams sufficiently focused on completing this task and forming concrete ideas.

Furthermore, the drawn posters seemed to act as boundary objects that enhanced the thinking, communication and mutual understanding about the service and its feature ideas within a team, similarly to what Pöyry-Lassila et al. (2013) list as important characteristics why boundary objects are used in co-development workshops. Also, the drawn posters assisted group reflection and communication process by making knowledge-in-progress explicit and debatable, as well as fostered the creativity in groups, similarly to 'heuristic sketches' described by Eppler and Burkhard (2007). Moreover, the drawn posters helped communicate more complex thoughts about how the actual service would work. This finding is explained by theory about how external visual representations – such as posters – enhance cognitive power (Kirsh, 2010). In other words, the mostly or completely drawn posters acted as different kind of boundary objects and influenced the knowledge co-creation and service co-design differently compared to mostly or completely empty posters.

The participants with the deepest relevant knowledge shared their knowledge often in the form of long monologues. Although this provided some interesting and deep understanding to other team members, it seems to have been to some degree a distraction from the actual task: forming feature ideas and drawing them on the posters. If the expertise and focus of these individuals were directed more strictly

on the workshop task, the posters likely could have influenced and supported the formation process of ideas and the whole co-design process even more.

In conclusion, empty posters (with the intention of drawing on them) or partly drawn posters increased idea formation and service co-design focus and productivity, whereas mostly drawn posters more improved communication and mutual understanding about the service and ideas related to it. However, to fully receive these benefits, it was necessary for participants to focus on the given task of co-creating feature ideas and drawing them on the posters.

How do boundary objects influence knowledge co-creation when co-designing services during a workshop?

This research question is general by its nature, and answering it based on empirical data of this study would require generalizations. Therefore, it is impossible to give a comprehensive answer to this question here. However, it is possible to discuss various relevant aspects, and consequently give a somewhat satisfactory, yet limited answer to this question.

Boundary objects influence knowledge co-creation when co-designing services during a workshop several different ways. They can enable service co-design by helping collaboration and creating common ground (Pirinen, 2016). They can limit collaboration if a boundary object is left unchallenged (Levina, 2005). Boundary objects serve as catalysts for knowledge co-creation (Paavola & Hakkarainen, 2005). They can be either made beforehand, or co-created during workshop (Paavola & Hakkarainen, 2005), and they can act both as outcomes of knowledge co-creation and as tools for reaching those outcomes, even simultaneously (Bereiter, 2002). Co-creating boundary objects helps knowledge co-creation through externalization, where tacit knowledge becomes explicit and crystallized (Nonaka, 1995; Nonaka, 2000). Boundary objects can also motivate collaboration and consequently improve focus on knowledge co-creation relevant for the service co-design goal (Nicolini, Mengis and Swan, 2012). They can improve focus on knowledge co-creation also by creating a place where ideas are saved (Kaner, 2014). Moreover, they can enhance thinking, communication and mutual understanding related to the service (Pöyry-Lassila et al., 2013), and help reflection and creativity in groups (Eppler and Burkhard, 2007). The already co-created boundary objects can enhance cognitive power and help communicate more complex knowledge related to a service (Kirsh, 2010).

The type, usage and purpose of boundary object and the aim and characteristics of the workshop all partly determine how a boundary object influences knowledge co-creation (Pöyry-Lassila et al., 2013). Visualizations and service prototypes – and visual prototypes such as Peili – tend to be effective boundary objects for service co-design (Blomkvist & Segelström, 2014). However, co-created boundary objects – such as posters in this study – are effective boundary objects too (e.g. Bereiter, 2002).

6.2 Practical Implications

Boundary objects are an effective way to help co-creation of relevant knowledge in service co-design workshops. Therefore, it is recommended that practitioners such as consultants, managers and other organizers and facilitators of such workshops utilize boundary objects. The type of boundary object should be chosen carefully depending on situation and goals, so that it is as relevant and effective as possible for knowledge co-creation related to co-design of a specific service.

Firstly, a boundary object that has been created before the workshop, and that acts as a context of a service co-design workshop can help participants have common enough understanding about what they are trying to co-design. This can be beneficial for the productivity of the workshop. Secondly, participants co-creating boundary objects during a workshop can increase their focus and productivity in relevant knowledge co-creation for the service co-design task or goal. Thirdly, after the participants have drawn a boundary object, it can be used for knowledge co-creation. Therefore, the boundary object should be drawn early enough to allow knowledge co-creation that uses this boundary object. This way the participants will have plenty of time to discuss about the service so that the co-created boundary objects support their communication about even complex characteristics of the service.

One practical implication is that lack of time – time pressure – can be an effective motivator that makes workshop participants stay more focused on relevant knowledge co-creation related to the service. The amount of time left negatively correlated with the productivity of teams in this study: the less time there was left, the more intensively participants focused on the task. Also, the mere perception that there is not much time left can motivate participants to be more productive. Consequently, creating a continuous sense of urgency for workshop participants to complete the service co-design task may be an effective way to increase the productivity of such workshops. For example, reviewing the progress of the teams in

the middle of the assignment could increase such sense of urgency. Organizers and facilitators of service co-design workshops should take this into account when arranging such workshops.

The most knowledgeable workshop participants may provide invaluable knowledge to the service co-design session. However, the small data sample in this study indicates that such individuals have tendency to spend a big portion of their team's workshop time talking about deep, detailed, complex knowledge related to their real-world area of expertise, instead of directly focusing on the workshop task – in this case co-creating posters with visualized feature ideas. Therefore, another practical implication is that it may be beneficial for the knowledge co-creation and service co-design productivity to make sure such workshop participants direct their focus effectively during the workshop. Facilitators have crucial role in this.

6.3 Theoretical Implications and Future Research

The theoretical goal of this study was to increase understanding about how boundary objects influence knowledge co-creation in service co-design workshops. Many results of this study strengthen the existing theory, since theory explains well most findings. The high-level empirical result – that boundary objects can be an effective way to support relevant knowledge co-creation in service co-design workshops – was highly expected based on theory. Several theoretical concepts – about what knowledge (co-)creation and boundary objects are – apply also to this study (e.g. Paavola & Hakkarainen, 2005; Bereiter, 2002; Nonaka, 1995; Nonaka, 2000). Likewise, the influence and benefits of boundary objects in knowledge co-creation and service co-design in the empirical study are largely similar to ones in theory (e.g. Pirinen, 2016; Nicolini, Mengis and Swan, 2012; Pöyry-Lassila et al., 2013; Eppler and Burkhard, 2007; Kirsh, 2010).

However, there were also some more interesting, less expected empirical findings. Time pressure – or at least perceived lack of time – seemed to act as an effective motivator and improved significantly the focus and productivity of teams in relevant knowledge co-creation and service co-design. The current theory of knowledge co-creation and service co-design does not pay much attention to this aspect. But, there are theory in the research field of creativity that acknowledges time pressure's role in creative pursuits and the role of lack of time as motivator (e.g. Basadur, 1991; Chirumbolo et al., 2004; Blair & Mumford, 2007).

Therefore, to fill this gap in theory, future studies that focus on time pressure's effect in the context of boundary objects, knowledge co-creation, and service co-design are justified. Time pressure also is needed to get out the first boundary object that thereafter can be used for co-creating new knowledge during the time left. This way time pressure can lead to realization of the benefits of external representations listed by Kirsh (2010).

Another interested empirical finding not discussed in relevant theory, was that the most knowledgeable workshop participants spent a big portion of their team's time talking but were often focused more on less relevant details and stories than effective, relevant knowledge co-creation and the service co-design task. More research is needed to find out if this only happened in this study, or if it is a common phenomenon in service co-design workshops. In addition, more future research may be needed about facilitation and how facilitators can solve this kind of problems that distract team's focus from effective knowledge co-creation and service co-design.

Finally, since arranging physical workshops – where all experts must be physically present simultaneously – can be difficult to arrange due to scheduling and distance, another important future research area may be knowledge co-creation and service co-design digitally, in web-based manner. For example, co-creating boundary objects relevant for co-design of a service in cloud platforms might be in some cases effective alternative for physical workshops.

6.4 Evaluation of the Study

Since this is a qualitative case study, the results of this study are not recommended to be interpreted as generalizable across samples. Instead, this study can increase the understanding about its topic. (Yin, 2009)

There were several limitations in this study. Firstly, the amount of data is limited. All empirical data was gathered from just one workshop. Also, there were only two different teams whose discussions were used as data. Furthermore, there were only two types of boundary objects used – one service prototype and six co-created posters. Therefore, the results of this study obviously cannot be reliably generalized to all

types of boundary objects. Also, in a different type of service co-design workshop or with different workshop participants the results could easily be very different.

Secondly, the quality of data is limited. Some comments in the discussion audio are not clear. At times, speech volume is too low, speaker is too far away from microphone, several people speak simultaneously or otherwise speech is not understandable. Also, in some moments the identity of the speaker cannot be reliably recognized. Consequently, some comments and details of the discussions were missed. Also because of these factors, some quotes used in this study are slightly different, shortened, or simplified versions of what was really said. In addition, the video capture was successful only from part of the duration of the workshop, and it mostly did not give very detailed information. However, the data quality seems to have been good enough to sufficiently capture the most important characteristics of the idea formation and service co-design process and other most relevant aspects. For example, there are accurate photos of all posters co-created in the workshop.

On one hand, it was important that the researcher and other MORFEUS-researchers were present in the service co-design workshop on which this study focuses. This supports the researcher's understanding about what happened in the workshop. On the other hand, this may have led to some bias in the data and the conclusions. Furthermore, the researcher and other MORFEUS-researcher were also the designers and developers of Peili, which may be other factor increasing the bias of this study.

The qualitative single-case study nature of this study and the limited amount of data decrease the reliability of this study: another similar study with different data might have significantly different results. The validity – the accuracy of results of this study – may have been to some degree negatively affected from the factors such as data quality and subjective interpretations as well as inexperience of the researcher. However, analyzing the role of several boundary objects in the formation of many different ideas from more than one team, are factors likely to have a positive effect on the reliability and validity of this study. In addition, the volume of discussion data is relatively high (52 pages of transcriptions), which also may increase the validity and reliability.

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Appendices

Appendix 1: Additional pictures of Peili's user interface

PEILI

My HealthSupport NetworkMessagesObjectivesServicesMy DataLog out



Sam Citizen

Contact

Social security number: 060885-1234
First Name: Sam
Last Name: Citizen
E-mail: sam.citizen@gmail.com
Phone: 041-465873172
Address: Kolmas Linja 16 A 2 00530 Helsinki

Health

Medical conditions (imported from Kanta):

Condition	Detection Date	Handler	Contact person	Status
Atrial Fibrillation	15.09.2014	HUS	Danny Doctor	Follow-up treatment
Antibiotic Resistance	06.04.1989	KYS	Diana Doctor	Finished

Allergies (imported from Kanta):

Condition	Detection Date	Handler	Contact person	Status
Allergic Rhinitis	06.04.1989	KYS	Diana Doctor	Finished

Prescription (imported from Kanta):

Condition	Period of validity	Handler	Contact person	Status
Antabuse	08.05.2016 - 31.12.2016	HUS	Danny Doctor	Finished

Timeline

Timeline provides a simple way to see data from different sources and combines them to one extensive view.

2:41 PM
May 20, 2016
Weekly Meeting

2:40 PM
Doctor Appointment



Unemployment support

Housing support

Doctor Appointment

Weekly Meeting

MARCHAPRILMAYJUNEJULY

Type
- Any -

Social


















In amusement park with Liz :) What a beautiful day it is.

Interest

Interest: Jewellery making

Picture 4: Peili: Customer's 'My Data' View

Planning tool provides you an easy way to see what kind of services are needed.

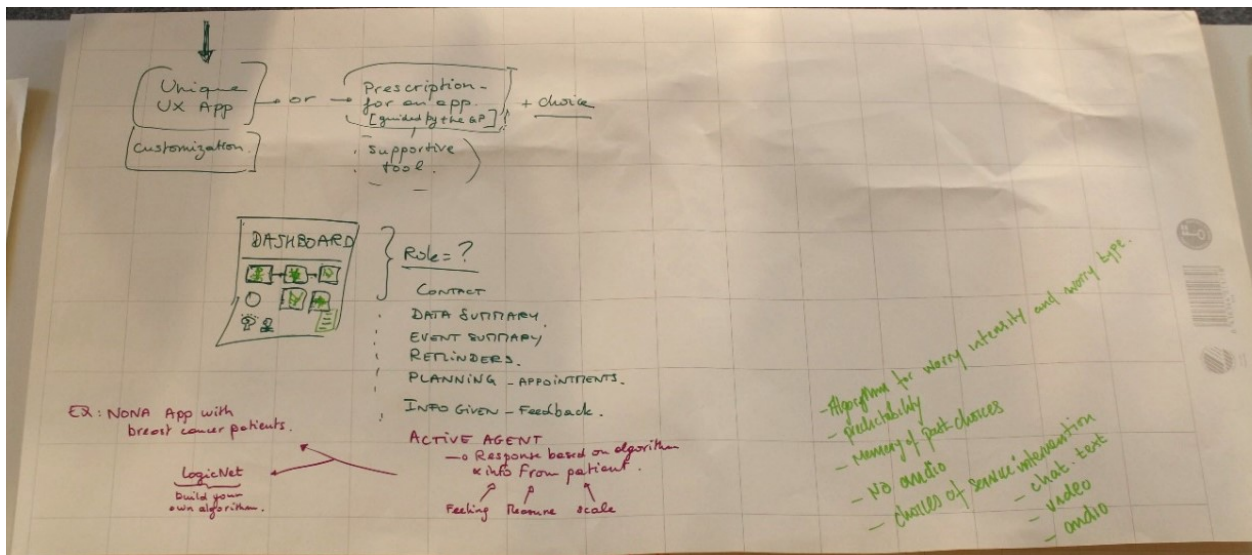
Jewellery making	Leather crafting	Metalworking	Yoga
  			 
Bodybuilding	Cycling	Hooping	Jogging
		 	
Mountaineering	Taekwondo	Vehicle restoration	
			

Picture 5: Case manager's/Professional's Planning Tool View

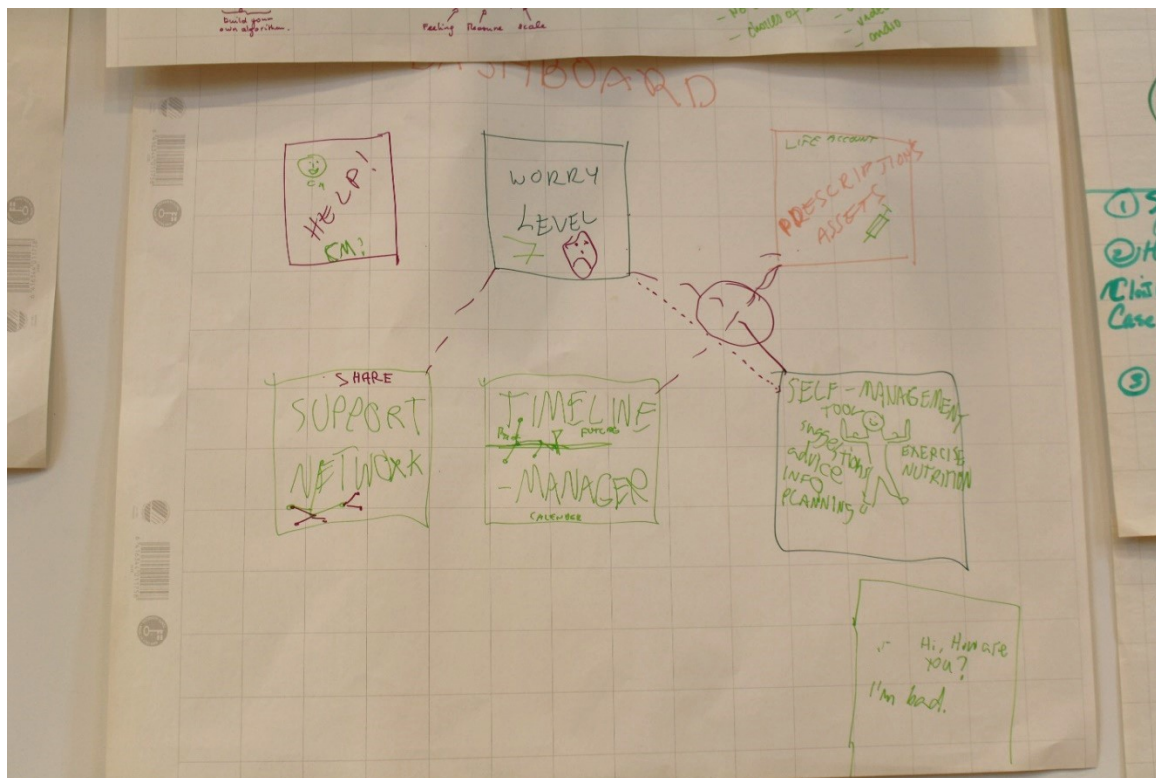
Appendix 2: Pictures of All Posters



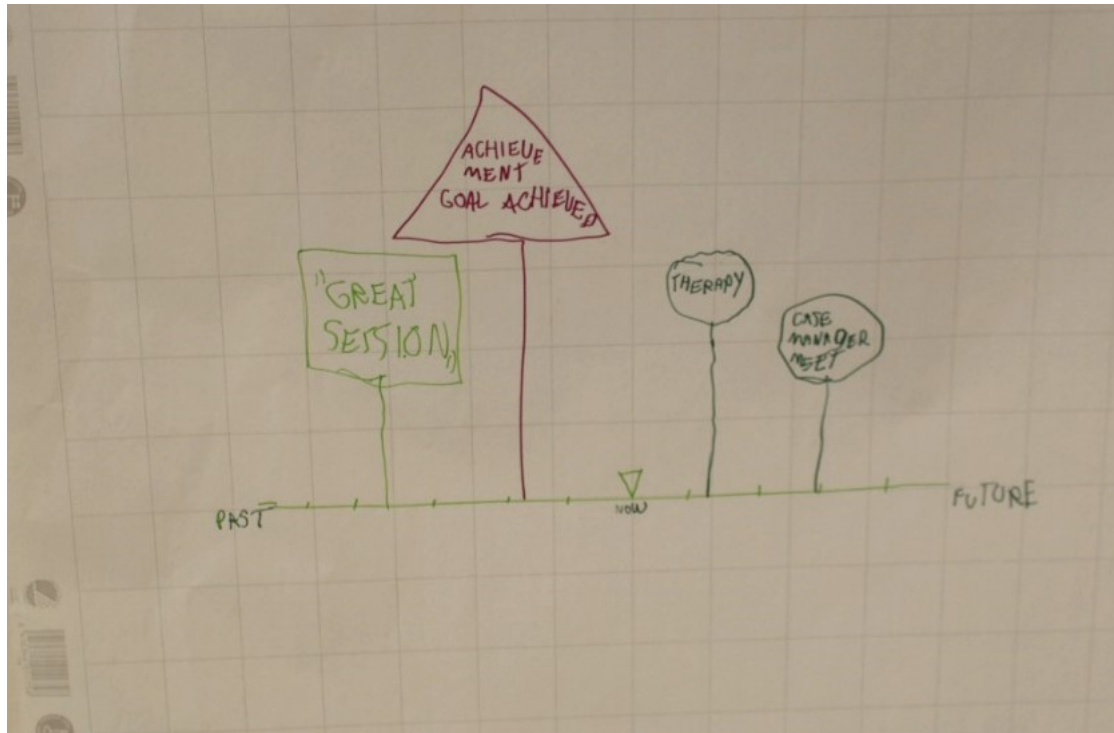
Picture 1: All posters and a facilitator



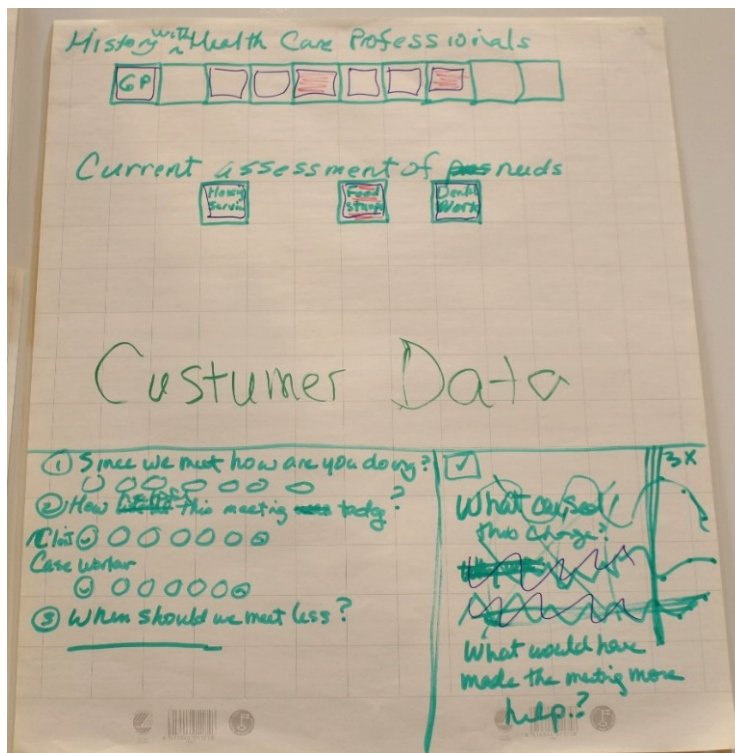
Poster 1: Dashboard and other written ideas (Customer team)



Poster 2: Dashboard (Customer team)



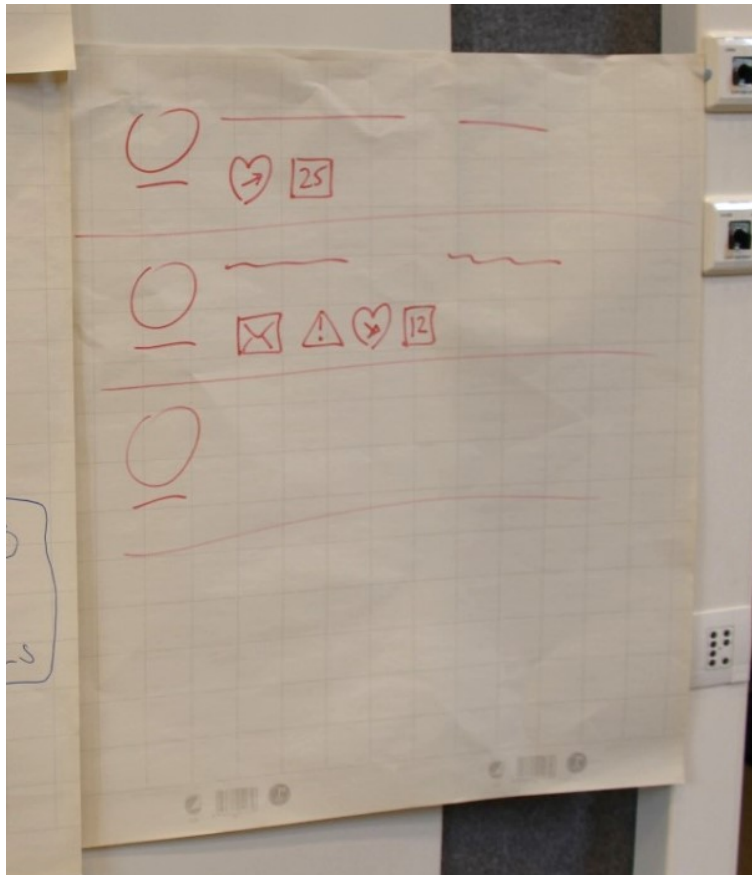
Poster 3: Timeline of meetings with professionals and other relevant events (Customer team)



Poster 4: Dashboard (Case manager team)



Poster 5: Holistic view of client's life situation (Case manager team)



Poster 6: List of clients with notifications (Case manager team)

Appendix 3: Lists of Ideas in Posters

Poster 1: Dashboard and other ideas (Customer team):

- Unique UX (user experience)
- Prescription for an app (by social or healthcare professional)
- + Choice (which tools/apps to use)

Dashboard:

- Contact
- Data & Summary
- Event summary
- Reminders
- Planning – appointments
- Info given (by patient/user) – Feedback (received from professionals or other people)
- Active agent
 - response based on algorithm & info from patient
 - feeling
 - ?
 - scale
 - Example: Nona App with breast cancer patients
 - LogicNet
 - Build your own algorithm
- Algorithm for worry intensity and worry type
 - predictability
 - memory of past choices
 - no audio
 - choices of se... intervention
 - chat – text
 - video
 - audio

Poster 2: Dashboard (Customer team)

- Help! -button/feature
- Inputting and tracking worry level
- List of prescriptions and other similar data
- Support network
- Timeline (also in **Poster 3**)
 - feedback or info about a session
 - achievements/goals
 - therapy sessions
 - meetings with case manager
- Self-Management tool
 - Suggestions
 - Advice
 - Info
 - planning
 - exercise
 - nutrition
- Chat

Poster 3: Timeline (Customer team)

- Meetings with professionals
- Comments by professional or client
- Goals and achievements

Poster 4: Dashboard (Case manager team)

- History with health care professionals
- Current assessment of needs
- (other) Customer data
- Data input by customer:

- surveys
 - Since we met how are you doing? (1-7)
 - How helpful was this meeting? (1-7)
 - Case worker? (1-7)
 - When should we meet less?
 - What would have made the meeting more helpful?

Poster 5: Holistic view of client's life situation (Case Manager team)

- Positives
 - job
 - hobbies
- Family
- Friends
- Daily needs
 - housing
 - car/transport
 - money
- Health
 - Strengths
 - gym
 - Problems
 - alcohol
 - dental
 - Medication
- Professionals helping me

Poster 6: List of clients with notifications (Case manager team):

- List of clients with notifications
 - unread messages from that client

- date of next meeting
- direction/state of client's progress/situation
- other notifications related to the client

Appendix 4: References to Peili in Team Discussions

The participant who was also the main developer of Peili was heavily involved in these references. All these conversations happened in the case manager team.

Reference 1: He explains some current functionalities of Peili:

CM7: Yeah. Now you can open it by the... these pages are now under construction, but open it up and see the different kind of record from each.

CM5: Full report by the doctor... Who is the, who writes it?

CM7: Well, that's something you can still develop and figure out. What kind of information should be there?

CM5: It actually includes what the customer says. Went to the doctor today [?? 00:42:22] or helpful.

CM7: Yeah because I was thinking, at least for the customer view point it would be really nice to see the last document thing and what kind of report...

Reference 2: He seems to be referring again to Peili's interface and functionalities:

CM7: So actually here you can see all the information points from the different applications.

CM1: Yeah, we see all of them.

CM7: But you could also filter the search with the...

[?? 00:43:12]

CM7: Yeah, these are different ones.

Reference 3: He seems to be speaking quite directly about Peili:

*CM7: The main idea of this **dashboard** is the national data layer, so how can we build a system that works nationwide, with all the data, it's automatically there. You don't have to...*

Reference 4: Here he refers twice to the development of Peili:

CM1: So when you click on each one, does it have something under that?

*CM7: **Yeah, we actually just thought of it...***

CM1: Okay, it's mostly health care data, but maybe that's where you want your meeting notes.

CM5: Well then the last thing I've got here is the meeting...

CM1: But I think you would put them under the person.

CM5: Well yeah, it's a database, so...

*CM7: **It's actually already developed.***

CM5: So the access from the history...

CM1: Ah.

Appendix 5: Long Quotes from Discussion

Quote 1

CU1 [70min]: Tähän listasin näitä = "I listed these here"

CU2: Mikä tän nimi on? = "What is the name of this one?"

CU1: **Worry level.**

CU2: Se oli tää seuraava. = "That was this next one."

CU1: Oliko se ihan **timeline**? = "Was it just timeline?"

CU2: Se oli tota. = "It was."

CU3: I'm gonna get one of these.

CU2: Tää oli se. = "This was it."

CU1: Kontaktit. = "Contacts".

CU2: Tää oli se apua. **Worry level. Tää oli se help.** = "This was the help. Worry level.
This was the help"

CU1: Semmonen, että nyt tarvii. = "Like so, that now you need it."

CU2: Mikäs kolmonen oli? = "What was number three?"

CU1: Oiskohan se ollu lääkitys ja muu perusterveysinfo. Med info. = "It may have
been medication and other basic health information. Med info."

CU3: So these are the pages then? Help. **Worry level**, that one was that. **Prescriptions
or assets** or top up or whatever.

CU1: **Support network. That can be green.**

CU3: Then this last one would be. That was going to be **timeline** but we were talking
about appointments. I'm not sure where the appointments would go.

CU1: It could go to timeline.

CU3: Timeline would be appointments. Time management. Time manager. It would record what you've done in the past and what you've got coming up as well. Now we leave it to you. We all have coffee and cake while you...

CU1: **Chat** with health coach. Or something like that.

CU3: Instant chat, 24 **hours chat**.

[?? 01:13:01]

CU3: **I'm bad**. I'm bad man.

[laughter]

CU3: Can you draw an icon? You know, what a network would look like. Your icon would be like network. Frames and stuff like that. This one would be **smiley** face of your case study, case manager. Worry level would be, what's that?

CU1: **Sad face**. [laughter]

CU3: Icon or it could be a **number 7**.

CU1: **It can be both**.

Quote 2

CU1 [75min]: What else? We have lots of empty space. Should there be videos or pictures or audio?

CU3: I think that's a part of this. When you click onto this, it's the assets, maybe you can have a video about that.

CU1: Or would there be maybe some information, resources.

CU3: What information would we need?

CU1: Advice... It could recommend automatically based on your information, suggest depressed with bad physical health... Light exercise would be beneficial for you. It

would be a combination of advice and information. This is why exercise maybe good in your situation. Not too strongly because it's a robot. You must exercise, but kind of suggest. Then the user can check it and then decide if he wants to do it.

CU3: Help [?? 01:16:32] contact. That's something you choose. Then you get feedback from the system. Assets [?? 01:16:43] prescriptions or whatever you need.

CU2: I meant to prescription...

CU1: Maybe that's hard medical... History.

CU3: We can talk about something like that.

[?? 01:17:02] [overlapping speech]

CU3: I was just thinking, what is your last one, cos you're trying to give it a word.

CU1: Self-care or suggestions.

CU3: **Self-management.** I'm not very good at drawing upside down. You can **write self-management.** Get to know yourself. Then you can connect it to things like if you feel mindfulness or yoga. Those things that you can get out... That might be. You got worries 7, might trigger of, how about learn to meditate. What is your worry really about? That can be linked. High worry might trigger different suggestions. What's the role of support network? What would you expect? Your support network is your family or friends.

CU2: So you would remember they exist. You got contact. Contact them immediately as well.

CU3: Maybe that's it. We have to define exactly what would happen. You have a support network. I'm thinking what is the role of the support network is that they, you can call someone or they might call you or maybe...

[?? 01:19:23] [overlapping speech]

CU3: Case manager, so this can be someone from Keller. A different person you need to interact with.

CU2: When it comes to privacy, this might be good to remember that they exist, you might forget when you're desperate and going to jump down the roof, so you might remember that there are people you could actually contact.

CU1: At least in some cases maybe this could go both ways that these people could look at your situation and if you want, you can be the one who contacts them.

CU3: This is more like share. I think if you can write share whatever. I'm not really used to writing upside down, but let's try if I'm writing the right way. But anyway share or find or something like that. This is about self-management. This is about how you're feeling. This is practical stuff.

CU1: This is feelings, like, hard medical day...

CU3: This is about your calendar, your mapping, timeline.

CU1: This is sharing, acute for help. This could be used in many ways depending on your situation.

*CU3: Each time you'll go and you'll open up a page, so you're an app and you choose this one, then you're on a page and then it will be a network and have options of who to talk to. This one will be your **timeline**. It will have a calendar attached to it, make an appointment will be there. This one would just, just a basic how you're feeling today. You can rank yourself. But then you might select is the **worry** about pain, emotion. We had four categories. Then you select that. Then it'll calculate and the system will give you a score. That's all it does. It shares it with the case study manager of course. This woman's very worried.*

Quote 3

CU3 [84min]: Help is your contact, your case study manager. That's emergencies. You can call him or her any time. This is the dashboard. This is the functions. This one opens the page. Then we have, it calculates how we feel today, stress, worry level. It

literally comes up with a number. Once you choose it and you choose a few selections, the system will give you that. Then we have top up, which is your life account, so it's a prescription assets or whatever you need. Medical. This one is your support network. These are the people...

CU1: Hey, earlier we had this...

CU3: We'll just go through it and then we'll come catch up. Support network, your people that you can actually be public or private, you can share your stress level with them or you might not. This one is the time manager. Calendar with the past and present. When you make your calendar bookings, that can come up there. And this last one is a self-manager. If you have a bad stress, it might come up and say how about a bit of exercise. Suggestions. How about going to a yoga class. How can you manage yourself? If they really want to read it. There are four, and he'll say no, maybe he should have a text box. That's our dashboard, that's the functionality.

Sorry.

CU1: Okay yeah. The one idea that we already got here. The Estonian guy had it. We could prescribe apps for some specific customers, some specific situation, some app, some interface could be very suitable. His case manager could realise that oh this app could be good for you and recommend that for him.

CU3: Add that to this one you mean?

CU1: Maybe this one, maybe this one or maybe this. [laughs]

FA2: Okay, so behind these boxes you've got something like an app?

CU3: Each one is like a screen of this one app. This is one app. If you go to this, you'll go to how do you feel today, and you can rank yourself. And then there could be a category. [?? 01:26:39]. Then you click to get more information. We didn't draw the timeline. We thought of self-management, this is the network.

FA2: But you're going to?

CU3: Are we going to do that or not?

FA2: Is that it?

CU3: [?? 01:26:56]

FA2: Ten. We got another 15 minutes. You've got lots of interesting stuff going. I'm interested to know. Completely interested in your timeline, how you see that working because I want that to be very sexy.

*CU1: Do you want to make a bigger, more detailed timeline? We can definitely try.
[laughs]*

[?? 01:27:20] [overlapping speech]

CU1: Let's think what kind of things there would be in the timeline. There would be at least meetings, appointments with professionals.

CU3: I think maybe we should have a line.

CU1: That's a good start. [laughs]

CU3: Then we have now. This is the past. [?? 01:27:50] upside down all the time, but that's the past and present. Now present. That's the future. Now you're going to have a events, aren't you. How should we talk about these events?

CU1: One could be dentist.

CU3: How would you make appointments? For instance, if you say making appointment, you have to do a little box for that.

CU1: From here there would be a line and a circle like dentist. With different colours and shapes you could indicate different things on the timeline.

*CU3: Let's not put dentist because this is a drug user, so what would we put?
Someone else.*

CU1: Therapist? Let's put that. Or therapy.

CU3: Therapy. Then maybe the next one, who should we have. Case manager? Then you could do a different, square or something.

CU1: It's getting ugly.

*CU3: It's okay. Then maybe you could have almost the same here, but somehow the...
This would be dates. I think you'd have the same. Therapy and...*

CU1: What other types of things than meeting professionals could a customer have?

*CU3: They can have, I don't know if they really want to put emergencies or bad times.
Do they want to record that or just appointments? What is it that someone would
want... It's better to put positive times.*

*CU1: Any nutrition, exercise, anything about the behaviour that affects a person's
health, well-being? Or interests, hobbies? Maybe something social.*